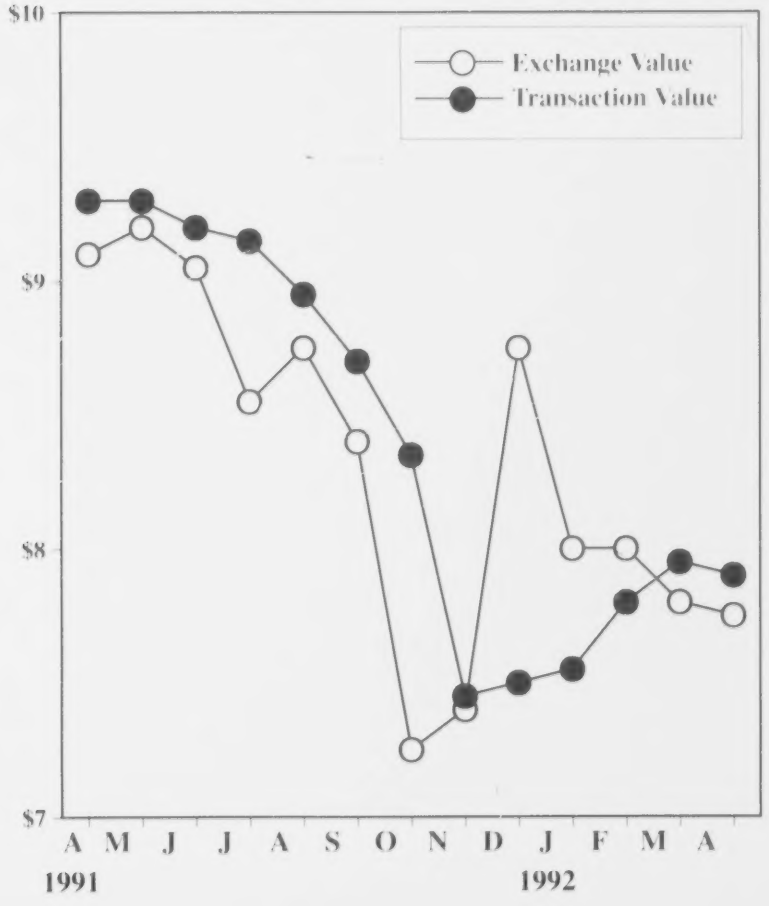
NUEXCO

Monthly Report

May 1992 **Number 285**

Spain's Uranium Industry 16

India's Nuclear Program 25



NUEXCO

International Headquarters

Oren L. Benton – Chairman
Earl E. Hoellen – Vice-Chairman and Chief Executive Officer
James J. Graham – President and Chief Operating Officer

Three Park Central, Suite 1000
1515 Arapahoe Street
Denver, Colorado 80202 USA

Telephone: (303) 899-4500
Fax: (303) 899-4555
Telex: 450202 (NUEXCO)

Service Locations

DENVER, COLORADO, USA
Three Park Central, Suite 1000
1515 Arapahoe Street
Denver, Colorado 80202
Telephone: (303) 899-4500
Fax: (303) 899-4555
Telex: 450202 (NUEXCO)

LONDON, ENGLAND
CONCORD Resources, Ltd.
The Exchange
71 Victoria Street
London, SW1H OHW England
Telephone: (44-71) 233-3083
Fax: (44-71) 233-3085
Telex: 267139 (299935 CCC G)

SAN FRANCISCO, CALIFORNIA, USA
Building 1, Suite 105
3000 Sand Hill Road
Menlo Park, California 94025
Telephone: (415) 854-1510
Fax: (415) 854-2115
Telex: 470674 (NUEXCO SF)

HONG KONG
1408 Shui On Centre
6-8 Harbour Road
Wanchai, Hong Kong
Telephone: (852) 824-3312
Fax: (852) 824-3320
Telex: 67206 (CNITC)

ZURICH, SWITZERLAND
NUEXCO Exchange AG
Leberngasse 15
4603 Olten, Switzerland
Telephone: (41-62) 320032
Fax: (41-62) 321450
Telex: 981600 (NUXCH)

WASHINGTON, D.C., USA
11 Dupont Circle,
Suite 505
Washington, D.C. 20036
Telephone: (202) 328-9250
Fax: (202) 328-6699
Telex: 451691 (NUEXCO DC)

SYDNEY, AUSTRALIA
Suite 2301 – Gateway
One Macquarie Place
Sydney, New South Wales 2000
Australia
Telephone: (61-02) 247-9999
Fax: (61-02) 247-9437

NOTICE

This Report is prepared especially for Subscribers and is furnished to them for their use only. Except for internal use by Subscribers, no part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of NUEXCO. Neither this Report, nor copies of any portion thereof, may be lent, sold or given to non-Subscribers.

The information in this Report was gathered from sources NUEXCO believes to be accurate. However, NUEXCO makes no warranty, express or implied, and assumes no legal liability or responsibility for the accuracy, completeness or usefulness of any information contained herein.

© 1992 NUEXCO

ISSN 0742-4582

NUEXCO Monthly Report

May 1992
No. 285

Published by:
NUEXCO
Three Park Central
Suite 1000
1515 Arapahoe Street
Denver, Colorado 80202 USA
Telephone: (303) 899-4500
Fax: (303) 899-4555
Telex: (303) 450202 (NUEXCO)

Managing Editor
Treva E. Klingbiel

Assistant Editor
Kenten D. Lindberg

Production
Alan L. Wolcott

Subscriptions
Sandra K. Lauer

TABLE OF CONTENTS

Market Review 1
- Market Values Summary
- April Market Review
- Current Market Data

Recent Developments 13
- Washington Focus
- Industry Briefs

Focus 16
- **Spain's Uranium Industry**
  This article is part two of a report focusing on Spain's nuclear program. This portion of the article details the country's uranium industry and the expansion plans for the Saelices el Chico uranium production project located in Salamanca Province.

- **India's Nuclear Program** 25
  India made an early commitment to being as self-sufficient as possible in nuclear energy and has largely achieved that goal. The country currently operates eight reactors, has six reactors under construction, and twelve more reactors planned. It also operates complete fuel cycle facilities including uranium mines and mills, heavy water plants, fabrication and reprocessing facilities, and radioactive waste management facilities.

Nuclear Industry Calendar 35

Historical Market Data 36

Government Statistics 43

© NUEXCO 1992

NUEXCO

To Our Readers

The 1991 Annual Review was mailed to our subscribers early this month. This special report summarizes 1991 nuclear fuel activities country-by-country, and analyzes developments in the spot and long-term uranium and enrichment markets.

* * *

We would like to draw your attention to the revised format for our tables that display the Market Values Expressed in Selected Currencies. We have added the countries of the People's Republic of China, the Czech and Slovak Federal Republic (CSFR), and Hungary. We also have revised the format to list all Market Values for a specific country on one page. We hope you find these changes result in a clearer and more concise presentation of the figures.

© NUEXCO 1992

Market Values Summary

NUEXCO Market Values	This Report April 30, 1992	Last Report March 31, 1992	12 Months Ago April 30, 1991
EXCHANGE VALUE [1]	**$7.75** / lb equivalent U_3O_8	$7.85	$9.10
UF_6 VALUE [2]	**$23.75** / kg U as UF_6	$24.00	$27.25
LOAN RATE [3]	**3.0 %** / annum	3.0%	3.5%
CONVERSION VALUE [4]	**$1.60** / lb U as UF_6	$1.60	$1.45
SWU VALUE [5] **(0.3 % tails assay)**	**$67** / SWU	$69	$52
TRANSACTION VALUE [6]	**$7.90** / lb equivalent U_3O_8	$7.95	$9.30
Transactions	**22**	26	22
Months	**3**	3	3
Millions of Pounds	**6.2**	5.7	5.6

DEFINITIONS

[1] The **Exchange Value** is NUEXCO's judgment of the price at which transactions for significant quantities of natural uranium concentrates could be concluded as of the date indicated.

[2] The **UF_6 Value** is NUEXCO's judgment of the price at which spot and near-term transactions for significant quantities of natural uranium hexafluoride could be concluded as of the date indicated.

[3] The **Loan Rate** is NUEXCO's judgment of the annual interest rate at which uranium loans could be concluded as of the date indicated.

[4] The **Conversion Value** is NUEXCO's judgment of the price at which spot and near-term transactions for significant quantities of conversion services could be concluded in the secondary market as of the date indicated.

[5] The **SWU Value** is NUEXCO's judgment of the price at which spot and near-term transactions for significant quantities of enrichment services could be concluded as of the date indicated.

[6] The **Transaction Value** is a weighted average price of recent natural uranium sales transactions. The calculation is based on prices paid in:

a) Transactions closed within the previous three month period for which delivery is scheduled within one year of the transaction date;

b) At least ten transactions;

c) Transactions involving a sum total of at least 2 million pounds equivalent U_3O_8.

DERIVATIONS AND COMMENTS

- All **Market Values** are expressed in terms of US$.
- All **Market Values** are based on:
  - Data from recently completed transactions.
  - Data from pending transactions.
  - Firm bids to buy or borrow, and firm offers to sell or lend.
  - Prices purchasers or rates borrowers have expressed a willingness to pay, but for which NUEXCO is not aware of firm bids to buy or borrow and prices sellers or rates lenders have expressed a willingness to accept, but for which NUEXCO is not aware of firm offers to sell or lend.
- Prices associated with deliveries under old or renegotiated contracts or other than arm's-length transactions are not included in the determination of these **Market Values**.
- In the determination of prices, NUEXCO does not consider charges for transportation other than that customarily provided by suppliers.
- The prices of services or materials delivered under long-term contracts with primary suppliers are not considered in the determination of the listed values.
- For the **SWU Value**, NUEXCO converts SWU prices at varying tails and product assays to equivalent SWU prices at a tails assay of 0.30 weight-percent (w/o) ^{235}U and a product assay of 3.0 weight-percent ^{235}U, assuming feed costs corresponding to the NUEXCO **Exchange Value** and **Conversion Value** determined as of the same date.
- In calculating the **Transaction Value**, NUEXCO does not account for the price of uranium delivered in connection with contracts which call for "market price" mechanisms. This exclusion applies particularly to contracts in which delivery prices are expressed as a function of future **Exchange Values** or any other indeterminate variable. Also excluded from the calculation are any other transactions in which the delivery price is defined in such a way that it can not currently be determined.
- The sample time for the **Transaction Value** is extended as necessary to satisfy the minima for the number of transactions and quantity of material. Other currencies are converted to US dollars using conversion rates in effect on or near the transaction date.

© NUEXCO 1992

NUEXCO

MARKET REVIEW

APRIL MARKET REVIEW

(as of April 30, 1992)

OVERVIEW

The spot market price for uranium weakened further during April, and at month end, the NUEXCO Exchange Value had fallen $0.10, to $7.75 per pound U_3O_8. Only two near-term concentrates sales were reported, totalling less than 300 thousand pounds equivalent U_3O_8. One long-term sale was reported.

The UF_6 Value also declined, as increased competition among sellers led to a $0.25 decrease, to $23.75 per KgU as UF_6. Two near-term natural UF_6 transactions were reported involving 1.8 million pounds equivalent U_3O_8.

While seven uranium transactions totalling 3.9 million pounds equivalent U_3O_8 were reported, April market activity was actually quite low. Of the seven transactions, three relatively large natural and enriched UF_6 sales that had been in negotiation for several months were reported and accounted for the large majority of the month's reported sales volume.

Year-to-date spot and near-term sales volume now equals 10.4 million pounds equivalent U_3O_8 in 40 sales (**Table 1**). If this pace is maintained throughout the year, total sales volume will approximate that of 1991, and average purchase quantity will continue its trend of decreasing volume per transaction.

The Conversion Value was unchanged at $1.60 per pound U as UF_6; three transactions totalling more than 1.4 million pounds U were reported. The Loan Rate also was unchanged, remaining at 3.0 percent per annum. No loans were reported during April.

Aggressive competition among suppliers forced the SWU Value down two dollars, to $67 per SWU. Four enrichment transactions were reported: one involved a moderate quantity of SWU and occurred earlier in 1992; the other three sales involved enriched uranium product (EUP) equivalent to more than 500 thousand SWU and 1.8 million pounds equivalent U_3O_8 of feed.

Table 1
NEAR-TERM URANIUM SALES SUMMARY

	April 1992		Year-to-Date	
	No. of Sales	Volume [1]	No. of Sales	Volume [1]
Concentrates	2	0.3	25	5.1
Natural UF_6	2	1.8	7	2.7
EUP	3	1.8	8	2.6
Total [2]	**7**	**3.9**	**40**	**10.4**

[1] Million pounds equivalent U_3O_8
[2] Due to independent rounding, columns may not equal total.

Table 2
NEAR-TERM SUPPLY/DEMAND SUMMARY

	Active Supply [1]	Active Demand [1]
• Uranium (thousand lbs equivalent U_3O_8)	5,135	710
• Supply/Demand Ratio:	7.2	
• Loan (thousand lbs equivalent U_3O_8)	6,170	2,000
• Conversion (thousand lbs U as UF_6)	4,185	2,115
• SWU (thousand SWUs)	780	85

[1] Supply and Demand tables in the Market Review section of this Report provide details for each category.

© NUEXCO 1992

NATURAL URANIUM AND CONVERSION

Spot market prices for uranium concentrates continued a slow decline in April, and the NUEXCO **Exchange Value** ended the month at **$7.75** per pound U_3O_8, down $0.10 from the end of March. Market activity slowed during the month as demand remained quite low. Both buyers and sellers have remained cautious during the on-going anti-dumping investigation against the former Soviet Union. Activity is likely to remain slow, at least until the International Trade Administration of the Department of Commerce releases its preliminary determination in the case on May 18.

Only two near-term concentrates sales were reported in April: buyers purchased a total of almost 300 thousand pounds equivalent U_3O_8 from intermediaries at prices related to published spot market indicators.

* * *

The **UF_6 Value** also declined in April, falling $0.25, to **$23.75** per kgU as UF_6. Limited sales opportunities resulted in increased competition among sellers, and led to downward pressure on the UF_6 market. Competition has been even more intense for UF_6 sales that call for delivery in late 1992 or early 1993, as some sellers may have increased supply availability during that period.

Two natural UF_6 transactions were reported: a US utility and intermediary purchased a total exceeding 1.8 million pounds equivalent U_3O_8 for delivery later this year.

* * *

One transaction is reported in the **long-term uranium market**. A utility purchased more than five million pounds equivalent U_3O_8 for delivery during the period 1992-1995.

* * *

The **Transaction Value** declined $0.05, to **$7.90** per pound U_3O_8, reversing four consecutive months of increasing Transaction Values. The April 30 Value was based on 22 transactions over three months involving 6.2 million pounds equivalent U_3O_8.

* * *

Active uranium supply declined by more than two million pounds (31 percent), falling to **5.1 million** pounds equivalent U_3O_8 at month end. However, relative to supply, **active uranium demand** fell even further. It decreased 35 percent,

Table 3
ENRICHMENT PRICES
(April 30, 1992)

Prices	This Month Report 285	Last Month Report 284	12 Months Ago Report 273
NUEXCO SWU Value ($US per SWU)	67	69	52
US DOE SWU prices: ($US per SWU)			
USC	121.50[1]	121.50[1]	117.85[2]
AFC	153.00[3]	153.00[3]	153.00[3]
Requirements	157.00[3]	157.00[3]	157.00[3]
Incentive Price (IP2)	104.67[4]	104.67[4]	100.68[5]
Calculated worth of enriched UF_6[6]: ($US per KgU as UF_6)			
2.0 % ^{235}U	212	217	200
2.5 % ^{235}U	297	304	276
3.0 % ^{235}U	386	394	355
3.5 % ^{235}U	476	487	436
4.0 % ^{235}U	568	580	517
4.5 % ^{235}U	660	676	600

[1] Effective 10/1/91.
[2] Effective 10/1/89 to 9/30/91.
[3] Effective since 10/1/84.
[4] Provisional IP2 for FY92: Effective 10/1/91 to 9/30/92, for up to 30% of annual requirements.
[5] IP2: Effective 10/1/90 to 9/30/91, for up to 30% of annual requirements.
[6] Calculated using the NUEXCO Exchange Value, Conversion Value, SWU Value and 0.30 % ^{235}U tails assay.

© NUEXCO 1992

to **710 thousand** pounds equivalent U_3O_8, as few discretionary buyers have sought material during the anti-dumping investigation. As a result, the **supply/demand ratio** increased to **7.2**.

* * *

The **Loan Rate** remained unchanged at **3.0** percent per annum. No loans were reported during April.

* * *

The **Conversion Value** also was unchanged, remaining at **$1.60** per pound U as UF_6. A dichotomy between the European and North American conversion markets continues to exist, as more demand and somewhat tighter supply have increased prices in Europe. In the USA, excess conversion capacity has caused suppliers to price more aggressively. With the April restart of Sequoyah Fuels' Gore, Oklahoma plant, this overcapacity situation in the USA is likely to continue in the near term.

Three near-term conversion transactions were reported during April. Intermediaries purchased 1.4 million pounds of conversion services for 1992 delivery.

ENRICHMENT SERVICES AND ENRICHED URANIUM PRODUCT

The April 30, 1992, **SWU Value** dropped two dollars, to **$67** per SWU, as several suppliers competed aggressively for limited sales opportunities. One near-term enrichment transaction was reported for a moderate quantity of SWU, although it occurred earlier in 1992. In addition, three April transactions involving EUP were reported. The buyers consisted of a utility and two intermediaries, who purchased material containing a total of 1.8 million pounds equivalent U_3O_8 of feed and more than 500 thousand SWU.

© NUEXCO 1992

RECENT TRANSACTIONS

Uranium Sales[1]

NUEXCO Transaction Number	Delivery Period	Approximate Quantity (thousand pounds equivalent U_3O_8)	Price Within Percentage Range[2] of Current Exchange or UF_6 Value	Buyer	Seller	Remarks
5411	1992	101-300	98-102	Producer	Intermediary	
5412	1992	301-600	98-102	Utility	R	UF_6
5413	1992	101-300	98-102	Utility	Intermediary	
5417	1992-1995	3,001-6,000	R	Utility	Intermediary	
5418A	1992	101-301	See Remarks	Utility	Utility	Contained in EUP
5419	1992	1,001-3,000	103-110	Intermediary	Producer	UF_6
5423A	1992	601-1,000	See Remarks	Intermediary	R	Contained in EUP
5424A	1993	601-1,000	See Remarks	R	R	Contained in EUP

R means that NUEXCO either does not know, or that NUEXCO has restricted that information to protect client or source confidentiality.

[1] Transactions listed are not limited to those in which NUEXCO was involved, but also include others of which NUEXCO is aware. NUEXCO may delay reporting some transactions in order to protect proprietary information.

[2] The ranges *Below 90, 90-97, 98-102, 103-110, Above 110*, represent percentages (rounded to whole numbers) of the appropriate current Exchange Value or UF6 Value. The endpoints of each range are included within that range.

© NUEXCO 1992

NUEXCO

MARKET REVIEW

RECENT TRANSACTIONS

Natural Uranium Loans[1]

NUEXCO Transaction Number	Delivery Period	Approximate Quantity (thousand pounds equivalent U_3O_8)	Price Within Percentage Range[2] of Current Loan Rate	Borrower	Lender	Remarks
No Natural Uranium Loans are reported						

Conversion Sales[1]

NUEXCO Transaction Number	Delivery Period	Approximate Quantity (thousand pounds of U equivalent)	Price Within Percentage Range[2] of Current Conversion Value	Buyer	Seller	Remarks
5420	1992	1,001-3,000	98-102	Intermediary	Converter	
5421	1992	301-600	98-102	Intermediary	Intermediary	
5422	1992	Less Than 50	R	Intermediary	Converter	

Enrichment Sales[1]

NUEXCO Transaction Number	Delivery Period	Approximate Quantity[3] (thousand SWU)	Price Within Percentage Range[2] of Current SWU Value[4]	Buyer	Seller	Remarks
5414	1992	301-600	R	Utility	Utility	Occurred earlier in 1992
5418B	1992	Less Than 50	See Remarks	Utility	Utility	Contained in EUP
5423B	1992	101-300	See Remarks	Intermediary	R	Contained in EUP
5424B	1993	101-300	See Remarks	R	R	Contained in EUP

R means that NUEXCO either does not know, or that NUEXCO has restricted that information to protect client or source confidentiality.

[1] Transactions listed are not limited to those in which NUEXCO was involved, but also include others of which NUEXCO is aware. NUEXCO may delay reporting some transactions in order to protect proprietary information.

[2] The ranges *Below 90, 90-97, 98-102, 103-110, Above 110,* represent percentages (rounded to whole numbers) of the appropriate current Market Value. The endpoints of each range are included within that range.

[3] If tails assay is unknown or unspecified, NUEXCO's calculation of SWU quantity assumes 0.30 % tails assay.

[4] Prices are usually normalized to 0.30 % tails assay. When prices and SWU values are expressed as discounts from a reference price (e.g., **X** dollars less than DOE's USEC base price at time of delivery), the percentage price range is based on the discounted prices, not on the reference price.

© NUEXCO 1992

SUPPLY AND DEMAND

Uranium Supply

NUEXCO Project Number	Quantity (Thousand Pounds equivalent U_3O_8) Spot or Near-term [1]	Intermediate or Long-term [2]	Delivery Period	Remarks
AVAILABLE FOR SALE:				
ACTIVE				
91-1505	500	—	1992	
91-1506	750	—	1992	U_3O_8/UF_6
91-1507	500	—	1992	
91-1511	1,300	—	1992	UF_6/UF_6c
91-1512	785	—	1992	UF_6
92-1119*	155	—	1992	
92-1501A	645	—	1992	UF_6c
92-1509	500	—	1992	UF_6
91-1268	—	600 per year	1992-1999	
TOTAL	**5,135**			
INACTIVE	**2,800**			
AVAILABLE TO LOAN:				
ACTIVE				
92-1008	500	—	—	UF_6
92-1072*	1,600	—	—	UF_6
92-1074	1,000	—	—	
92-1075	500	—	—	
92-1077	180	—	—	UF_6
92-1114*	390	—	—	UF_6
92-1503	2,000	—	—	
TOTAL	**6,170**			
INACTIVE	**2,600**			

* New or revised since last month.

[1] For delivery within one year, measured from the date of this Report. This category excludes material deliverable within one year under other than spot or near-term contracts.

[2] For delivery beyond one year, measured from the date of this Report.

Active Projects reclassified as Inactive since last month: 92-1017, 92-1076, 92-1087
Active Projects removed since last month: 91-1084, 92-1060

© NUEXCO 1992

NUEXCO

MARKET REVIEW

SUPPLY AND DEMAND

Uranium Demand

NUEXCO Project Number	Quantity (Thousand Pounds equivalent U_3O_8) Spot or Near-term[1]	Intermediate or Long-term[2]	Delivery Period	Remarks
INQUIRIES TO PURCHASE:				
ACTIVE				
92-1110*	360	—	1992	
92-1113*	250	—	1992	UF_6
92-1120*	100	—	1992	
91-1184	—	350 per year	1993-1997	
91-1290	—	310 per year	1995-1999	U_3O_8/UF_6
91-1294	—	250 per year	1996-2000	
92-1015	—	1,300 per year	1995-2004	
92-1032	—	200 per year	1996-1998	U_3O_8/UF_6
92-1064	—	100 per year	1993-1996	U_3O_8/UF_6
91-1197	—	2,210	1992-1997	U_3O_8/UF_6
91-1267	—	350	1993	UF_6
91-1283	—	5,225	1994-2000	U_3O_8/UF_6
TOTAL	**710**			
INACTIVE	**1,740**			
INQUIRIES TO BORROW:				
ACTIVE				
92-1505	500	—	—	
92-1511*	1,500	—	—	
TOTAL	**2,000**			
INACTIVE	*None reported*			

* New or revised since last month.

[1] For delivery within one year, measured from the date of this Report. This category excludes material deliverable within one year under other than spot or near-term contracts.

[2] For delivery beyond one year, measured from the date of this Report.

Active Projects reclassified as Inactive since last month: 91-1118, 92-1098

Active Projects removed since last month: 91-1227A, 92-1030, 92-1073, 92-1091, 92-1117

© NUEXCO 1992

SUPPLY AND DEMAND

Conversion Supply and Demand

NUEXCO Project Number	Quantity (Thousand Pounds U as UF_6) Within 3 Years[1]	Beyond 3 Years[1]	Delivery Period	Remarks
AVAILABLE FOR SALE:				
ACTIVE				
91-1500	440	—	1992	
91-1501*	1,100	—	1992	
92-1111*	1,545	—	1993	
92-1507	1,100	—	1992	
TOTAL	**4,185**			
INACTIVE	*None reported*			
INQUIRIES TO PURCHASE:				
ACTIVE				
91-1275	620	—	1992	
92-1068*	65	—	1992	
92-1107*	330	—	1993	
92-1508	1,100	—	1992	
TOTAL	**2,115**			
INACTIVE	*None reported*			

* New or revised since last month.

[1] Measured from the date of this Report.

Active Projects reclassified as Inactive since last month: *none*
Active Projects removed since last month: 92-1506, 92-1510

© NUEXCO 1992

NUEXCO

MARKET REVIEW

SUPPLY AND DEMAND

SWU Supply and Demand

NUEXCO Project Number	Quantity (Thousand Pounds equivalent U_3O_8) Spot or Near-term[1]	Intermediate or Long-term[2]	Delivery Period	Remarks
AVAILABLE FOR SALE:				
ACTIVE				
91-1509	200	—	1992	
91-1515	200	—	1992	
92-1124*	250	—	1992	
92-1501B	130	—	1992	UF_6e
TOTAL	**780**			
INACTIVE	*None reported*			
INQUIRIES TO PURCHASE:				
ACTIVE				
92-1058*	10	—	1992	
92-1079	35	—	1992	
92-1096B*	40	—	1993	UF_6e
90-1196	—	60 per year	1995 on	
91-1142	—	75 per year	1995-2000	
92-1016	—	170 per year	1996-2006	
91-1152	—	2,700	1995-2001	
91-1171	—	560	1995-1998	
91-1250	—	45	1993	UF_6e
92-1024	—	12	1993	
TOTAL	**85**			
INACTIVE	**280**			

* New or revised since last month.

[1] For delivery within one year, measured from the date of this Report. This category excludes material deliverable within one year under other than spot or near-term contracts.

[2] For delivery beyond one year, measured from the date of this Report.

Active Projects reclassified as Inactive since last month: *none*

Active Projects removed since last month: 91-1227B

© NUEXCO 1992

MARKET VALUES EXPRESSED IN SELECTED CURRENCIES[1]

Australia to Hungary	Australia (dollar)	Belgium (franc)	Canada (dollar)	China (renminbi)	CSFR (koruna)	EC (ecu)	Finland (markka)	France (franc)	Germany (mark)	Hungary (forint)
EXCHANGE VALUE										
per pound equivalent U_3O_8 as Concentrates										
This Month (Apr 30, 1992)	**10.23**	**262.98**	**9.24**	**42.77**	**219.94**	**6.23**	**34.75**	**43.11**	**12.78**	**610.16**
Last Month (Mar 31, 1992)	10.19	265.65	9.34	42.92	223.02	6.32	35.21	43.75	12.90	616.15
12 Months Ago (Apr 30, 1991)	11.64	319.07	10.49	48.09	—·—	7.65	36.30	52.52	15.55	—·—
per kg U as Concentrates										
This Month (Apr 30, 1992)	**26.61**	**683.69**	**24.02**	**111.20**	**571.81**	**16.20**	**90.36**	**112.08**	**33.23**	**1,586**
Last Month (Mar 31, 1992)	26.50	690.63	24.27	111.58	579.80	16.42	91.53	113.73	33.54	1,602
12 Months Ago (Apr 30, 1991)	30.25	829.52	27.28	125.02	—·—	19.89	94.36	136.54	40.42	—·—
UF_6 VALUE										
per kg U as UF_6										
This Month (Apr 30, 1992)	**31.36**	**805.90**	**28.32**	**131.08**	**674.02**	**19.09**	**106.51**	**132.12**	**39.17**	**1,870**
Last Month (Mar 31, 1992)	31.17	812.18	28.54	131.22	681.84	19.31	107.64	133.75	39.44	1,884
12 Months Ago (Apr 30, 1991)	34.85	955.47	31.42	144.01	—·—	22.91	108.69	157.27	46.56	—·—
TRANSACTION VALUE										
per pound equivalent U_3O_8 as Concentrates										
This Month (Apr 30, 1992)	**10.43**	**268.07**	**9.42**	**43.60**	**224.20**	**6.35**	**35.43**	**43.95**	**13.03**	**621.97**
Last Month (Mar 31, 1992)	10.32	269.04	9.45	43.47	225.86	6.40	35.66	44.30	13.06	623.99
12 Months Ago (Apr 30, 1991)	11.89	326.09	10.72	49.15	—·—	7.82	37.09	53.67	15.89	—·—
per kg U as Concentrates										
This Month (Apr 30, 1992)	**27.12**	**696.92**	**24.49**	**113.35**	**582.88**	**16.51**	**92.10**	**114.25**	**33.87**	**1,617**
Last Month (Mar 31, 1992)	26.84	699.43	24.58	113.00	587.18	16.63	92.70	115.18	33.97	1,622
12 Months Ago (Apr 30, 1991)	30.92	847.75	27.88	127.77	—·—	20.32	96.43	139.54	41.31	—·—
CONVERSION VALUE										
per pound U as UF_6										
This Month (Apr 30, 1992)	**2.11**	**54.29**	**1.91**	**8.83**	**45.41**	**1.29**	**7.18**	**8.90**	**2.64**	**125.97**
Last Month (Mar 31, 1992)	2.08	54.15	1.90	8.75	45.46	1.29	7.18	8.92	2.63	125.58
12 Months Ago (Apr 30, 1991)	1.85	50.84	1.67	7.66	—·—	1.22	5.78	8.37	2.48	—·—
per kg U as UF_6										
This Month (Apr 30, 1992)	**4.66**	**119.69**	**4.21**	**19.47**	**100.11**	**2.84**	**15.82**	**19.62**	**5.82**	**277.71**
Last Month (Mar 31, 1992)	4.58	119.37	4.19	19.29	100.21	2.84	15.82	19.66	5.80	276.86
12 Months Ago (Apr 30, 1991)	4.09	112.09	3.69	16.89	—·—	2.69	12.75	18.45	5.46	—·—
SWU VALUE										
per SWU at 0.30% ^{235}U Tails Assay										
This Month (Apr 30, 1992)	**88.47**	**2,274**	**79.89**	**369.77**	**1,901**	**53.85**	**300.46**	**372.72**	**110.49**	**5,275**
Last Month (Mar 31, 1992)	89.61	2,335	82.05	377.26	1,960	55.51	309.46	384.53	113.39	5,416
12 Months Ago (Apr 30, 1991)	66.50	1,823	59.96	274.80	—·—	43.71	207.40	300.11	88.84	—·—

[1] Calculated using currency exchange rates for the last business day of the month, as published in *The Wall Street Journal*.

© NUEXCO 1992

NUEXCO

MARKET REVIEW

MARKET VALUES EXPRESSED IN SELECTED CURRENCIES[1]

Italy to United States	Italy (lira)	Japan (yen)	Netherlands (guilder)	S. Africa (comm. rand)	S. Korea (won)	Spain (peseta)	Sweden (krona)	Switzerland (franc)	Taiwan (dollar)	UK (pound)	USA (dollar)
EXCHANGE VALUE											
per pound equivalent U_3O_8 as Concentrates											
This Month (Apr 30, 1992)	**9,607**	**1,033**	**14.38**	**22.28**	**6,159**	**801.70**	**46.13**	**11.72**	**193.35**	**4.36**	**7.75**
Last Month (Mar 31, 1992)	9,727	1,042	14.53	22.56	6,082	815.50	46.84	11.77	198.02	4.52	7.85
12 Months Ago (Apr 30, 1991)	11,480	1,239	17.49	25.36	6,604	957.29	55.73	13.13	244.79	5.26	9.10
per kg U as Concentrates											
This Month (Apr 30, 1992)	**24,976**	**2,685**	**37.37**	**57.93**	**16,011**	**2,084**	**119.93**	**30.46**	**502.66**	**11.34**	**20.15**
Last Month (Mar 31, 1992)	25,289	2,709	37.77	58.66	15,812	2,120	121.77	30.60	514.80	11.76	20.41
12 Months Ago (Apr 30, 1991)	29,845	3,222	45.46	65.92	17,170	2,489	144.87	34.13	636.39	13.67	23.66
UF_6 VALUE											
per kg U as UF_6											
This Month (Apr 30, 1992)	**29,441**	**3,165**	**44.05**	**68.29**	**18,873**	**2,457**	**141.37**	**35.91**	**592.52**	**13.37**	**23.75**
Last Month (Mar 31, 1992)	29,740	3,186	44.41	68.99	18,595	2,493	143.20	35.99	605.40	13.82	24.00
12 Months Ago (Apr 30, 1991)	34,376	3,712	52.36	75.93	19,776	2,867	166.87	39.31	733.02	15.74	27.25
TRANSACTION VALUE											
per pound equivalent U_3O_8 as Concentrates											
This Month (Apr 30, 1992)	**9,793**	**1,053**	**14.65**	**22.71**	**6,278**	**817.21**	**47.02**	**11.94**	**197.09**	**4.45**	**7.90**
Last Month (Mar 31, 1992)	9,851	1,055	14.71	22.85	6,159	825.89	47.43	11.92	200.54	4.58	7.95
12 Months Ago (Apr 30, 1991)	11,732	1,267	17.87	25.91	6,749	978.33	56.95	13.42	250.17	5.37	9.30
per kg U as Concentrates											
This Month (Apr 30, 1992)	**25,460**	**2,737**	**38.10**	**59.05**	**16,321**	**2,125**	**122.25**	**31.05**	**512.39**	**11.56**	**20.54**
Last Month (Mar 31, 1992)	25,611	2,744	38.25	59.41	16,013	2,147	123.32	30.99	521.36	11.91	20.67
12 Months Ago (Apr 30, 1991)	30,501	3,293	46.46	67.37	17,547	2,543	148.06	34.88	650.38	13.97	24.18
CONVERSION VALUE											
per pound U as UF_6											
This Month (Apr 30, 1992)	**1,983**	**213.19**	**2.97**	**4.60**	**1,271**	**165.51**	**9.52**	**2.42**	**39.92**	**0.90**	**1.60**
Last Month (Mar 31, 1992)	1,983	212.40	2.96	4.60	1,239	166.22	9.55	2.40	40.36	0.92	1.60
12 Months Ago (Apr 30, 1991)	1,829	197.49	2.79	4.04	1,052	152.54	8.88	2.09	39.00	0.84	1.45
per kg U as UF_6											
This Month (Apr 30, 1992)	**4,373**	**470.01**	**6.54**	**10.14**	**2,803**	**364.89**	**21.00**	**5.33**	**88.00**	**1.99**	**3.53**
Last Month (Mar 31, 1992)	4,371	468.26	6.53	10.14	2,733	366.44	21.05	5.29	88.98	2.03	3.53
12 Months Ago (Apr 30, 1991)	4,033	435.40	6.14	8.91	2,320	336.28	19.58	4.61	85.99	1.85	3.20
SWU VALUE											
per SWU at 0.30% ^{235}U Tails Assay											
This Month (Apr 30, 1992)	**83,054**	**8,927**	**124.28**	**192.64**	**53,242**	**6,931**	**398.81**	**101.30**	**1,672**	**37.72**	**67.00**
Last Month (Mar 31, 1992)	85,502	9,160	127.68	198.33	53,459	7,168	411.69	103.46	1,741	39.75	69.00
12 Months Ago (Apr 30, 1991)	65,599	7,083	99.92	144.89	37,739	5,470	318.43	75.01	1,399	30.04	52.00

[1] Calculated using currency exchange rates for the last business day of the month, as published in *The Wall Street Journal*.

© NUEXCO 1992

WASHINGTON FOCUS

by Linda L. Gunter

The House of Representatives is gearing up to pass energy legislation possibly in June. The key committees have all considered versions of the House energy bill, and activity has moved behind closed doors as the committee chairmen meet to work out compromises on issues in their jurisdiction. Currently, sources indicate the Rules Committee may meet the week of May 18 to shape a final bill for consideration on the House floor.

House National Energy Bill HR 776

◇ On April 28, the House Ways & Means committee held a hearing on certain provisions of the National Energy bill (HR 776) and its tax implications. Included in the committee's jurisdiction was the mechanism for funding the decommissioning and decontamination (D&D) of the gaseous diffusion plants (GDP) by means of a retroactive assessment on US utility customers. Representatives of the Department of Energy (DOE) and the Treasury Department, as well as several witnesses from the utility industry and the National Taxpayers Union, testified at the hearing.

The administration did not present a unified opinion on the D&D fund. The Treasury's spokesman testified that the funding mechanism in HR 776 is similar to DOE's budget request of 0.33 mill per kilowatt-hour and therefore consistent with the administration's intent to fund D&D. However, DOE's representative testified that HR 776 creates an unfair burden on US utility customers. DOE has acknowledged in the past that the US government (i.e. the military) and foreign utility customers have some financial obligation. In his testimony, the DOE spokesperson stated that since the total amount of money necessary to do the cleanup is not yet known, it is premature to legislate a specific revenue requirement from the utilities. He added that DOE's internal financial analysis of the bill shows the new corporation should make $140 million in revenue the first year, leaving $360 million to be paid by the utilities.

In questioning the administration witnesses, several Congressman noted that the bill's funding provision creates an unfair tax on nuclear utility ratepayers, and Chairman Rostenkowski noted that this fee will be passed on to consumers through higher rates. Several committee members asked DOE about the agreement to share costs between the Department of Defense and commercial customers. DOE has not issued its policy statement, but the representative stated that contractor reports on the total cost of D&D support a 50-50 cost sharing. This statement is questionable however, in view of a Martin Marietta report indicating that 90 percent of the contamination is attributable to the Department of Defense. Rep. Nancy Johnson (R-CT) asked if the 50-50 allocation is based on the amount of uranium used in the enrichment process or the level of enrichment. The DOE spokesperson responded that the allocation is based on the uranium used. Johnson then replied that DOE should look at the pollution caused by the level of enrichment.

The utility witness panel, which included representatives of Commonwealth Edison, Philadelphia Electric, and Southern California Edison, said the utilities are willing to pay a share, but do not feel they should bear the entire burden. They asked the committee to consider capping the utilities' liability at $2.5 billion or 15 years, whichever comes first. The utility representatives also said the

© NUEXCO 1992

uranium mill tailings cleanup should be funded from another source, not the GDP D&D fund, since mill tailings are a government, not a ratepayer, responsibility.

The National Taxpayer's Union (NTU) urged the Committee to support HR 776, since NTU perceives that the bill will protect the taxpayer from the D&D liability. NTU claimed the $500 million revenue to be achieved by the corporation would be a taxpayer contribution. It added, however, that if the corporation is unsuccessful in making a $500 million profit, the utilities should be responsible for supplying the difference. If the utilities were successful in having their liability capped at $2.5 billion, then NTU will demand an $11 billion payment from the corporation to pay "unrecovered government costs".

The Ways & Means Committee marked up the bill on April 29 and 30. The utilities were successful in having their liability capped at $2.5 billion or 15 years. Individual utilities will be responsible for any shortfall from the $500 million profit, their portion to be determined on the basis of past SWU purchases. The mill tailings funding was removed from the D&D fund. Rep. Robert T. Matsui (D-CA) offered an amendment to give a tax credit to solar and wind producers, which was adopted. This amendment, in order to be revenue neutral, necessitated the removal of a resource depletion allowance for uranium mining. The Committee adopted its energy bill by voice vote.

Republics File For Injunction in International Court

◇ Judge Jane Restani of the Court of International Trade held a hearing on May 4 to consider whether the republics of Tajikistan and Ukraine, and the companies of Techsnabexport, NUEXCO, and Global Nuclear Services and Supply Ltd. were entitled to a preliminary injunction against the Department of Commerce (DOC). DOC has announced its intention to continue the anti-dumping proceeding against the independent republics, even though the petition was filed against the Soviet Union. At the hearing, a lawyer representing the Russian Federation asked to join the case, in support of the republics and the other plantiffs. The judge left the record open until May 11 to enable parties to respond to Russia's motion to intervene.

The judge heard arguments regarding the anti-dumping law, specifically whether it permits DOC to continue the investigation against the former Soviet Union and to apply the results to the newly independent republics. The hearing also addressed the questions of whether the court has jurisdiction over the case, and whether there has been any irreparable injury to the republics. The republics and the companies contend that the Commerce Department's April decision to continue the case has no basis in law because the Soviet Union no longer exists. Since DOC has now indicated its intention to pursue this action against the individual republics, the republics believe the court has the authority to issue the order granting a temporary injunction against DOC. The republics claim they received no timely notice that the dumping case was applicable to them, and thus have been denied the right to participate in the case from the beginning, putting them at a severe disadvantage. One issue in the case also revolves around the question of whether the republics are being treated fairly by the non-market country analysis applied to communist countries, as the Republics are adopting market-economy principles. Since Congress never anticipated that a country would cease to exist when it enacted the anti-dumping law, the Commerce Department is faced with unique issues in dealing with this case. The Court likely will issue its decision prior to the May 18 deadline for DOC's preliminary determination on the dumping investigation.

© NUEXCO 1992

INDUSTRY BRIEFS

Cogema and CEA Obtain Greater Autonomy in Foreign Investments

The government of France has granted Cogema and CEA-Industrie greater autonomy in their foreign investments. The government removed the requirement in which the companies had to obtain approval from the minister of economic affairs and other ministers with interests in the area prior to making the investment.

◆ ◆ ◆

Sweden's Sydkraft Buys Competitor Baakab

Sydkraft, Sweden's second largest power producer, has concluded an agreement whereby it will purchase another Swedish power producer, Baakab AB. The 10.6 billion krona (US$1.75 billion) purchase will increase Sydkraft's electrical production by over 25 percent, to 29 Terrawatt-hours. Baakab generates its power primarily from hydroelectric or fossil-fueled stations, but Baakab does have a five-percent interest in the Oskarshamn nuclear power station. This portion, added to its previous ownership, gives new-owner Sydkraft a total interest of 53 percent in the Oskarshamn plant.

The acquisition is one of several recent consolidations in the Swedish power industry, as the country prepares for Europe's restructured and more open electricity market.

NRC Clears Sequoyah Fuels to Restart Oklahoma Plant

On April 14, the US Nuclear Regulatory Commission (NRC) gave its approval to Sequoyah Fuels Corporation to restart operations at its Gore, Oklahoma plant. The plant had been shutdown by the NRC on October 3, 1991.

The NRC approved a staged restart, as proposed by Sequoyah in an April 1 meeting with the Commission. The NRC has had inspectors on-site 24 hours a day, and must approve each stage of the restart operations. The first stage commenced on April 16 and resumed the plant's depleted UF_4 operations. However on May 1, a pipeline gasket failed in the UF_4 production building and led to a small release of uranium. The event was not serious and the building was decontaminated soon after the incident.

The first phase of the restart of the UF_6 facility—the warm up of some key components on the main UF_6 line—began near the end of April and was not affected by the UF_4 incident. Nevertheless, the complete restart of the entire plant likely will be delayed at least a week until the root cause of the UF_4 incident is identified.

Sequoyah's license for operating the plant expired in September 1991, but as it has submitted to the NRC an application for a 10-year renewal of its license, Sequoyah is allowed to continue operating the plant during the renewal review period.

NRG Pulls Back From Nuclear Fuel Market

During April, NRG Group, a subsidiary of Northern States Power Company (NSP), stated it will discontinue brokering nuclear fuels to focus on more profitable projects. NRG's only remaining involvement in the nuclear fuel market will be through Graystone Corporation, another NSP subsidiary, that is a joint-venture partner in Louisiana Energy Services. NRG's statement did not preclude it from returning to the nuclear fuel market at a later date, but at present, the fossil-fuel and waste-as-fuel activities of the company are more profitable.

◆ ◆ ◆

FPL's St. Lucie 2 Breaks LWR Record

On April 21, the St. Lucie 2 839-MWe pressurized water reactor, owned and operated by Florida Power & Light Company (FPL), set the light water reactor record for continuous operation at 502 days, stopping at that point for a planned shutdown. The record previously was held by the Wolf Creek plant, which set a record of 487 days in September 1991.

The United Kingdom's Oldbury 1, a 217-MWe Magnox reactor owned and operated by Nuclear Electric, holds the record for all types of commercial reactors at 713 days. However, it has a distinct advantage over LWRs in that it does not need to be shut down for refueling.

© NUEXCO 1992

NUEXCO

FOCUS

SPAIN'S URANIUM INDUSTRY

This article is part two of a report focusing on Spain's nuclear power industry and its uranium program. In last month's issue (April 1992 Monthly Report, No. 284), part one described the country's nuclear power program. This portion will detail Spain's uranium industry and the expansion plans for the Saelices el Chico uranium production project located in Salamanca province.

INTRODUCTION

Spain currently operates nine nuclear reactors totalling over 7,100 MWe of capacity, contributing about one-third of all electricity generated in Spain. Four reactors at advanced stages of construction remain mothballed as the result of a government-imposed moratorium, and a fire at Vandellos 1 in 1989 led to its premature closure and to a revival of anti-nuclear sentiment in the country.

In the new national energy plan, which was sent to the Spanish Parliament on July 25, 1991, Spain opted to continue the nuclear moratorium that began in 1984 and rely upon conservation measures, additional natural gas imports, and electricity imports to meet expected demand. Under the new plan, nuclear power's share of Spain's total installed electrical generating capacity will fall from about 17 percent in 1990, to approximately 14 percent by the end of the century, as only the current nuclear facilities will continue to operate and no new nuclear plants will be built. Spain's integration into the European Community also is affecting the country's energy plans, prompting consolidation within the Spanish electricity sector in order to be more competitive in Europe. To supply the existing reactors, the government is supporting a major expansion of the country's domestic uranium industry.

URANIUM INDUSTRY

Spain's nuclear program is under the supervision of the Ministry of Industry and Energy (MIE). The functionary agencies within the MIE include the state-owned Centro de Investigacion Energética, Medioambiental y Technología (CIEMAT) [formerly the Junta de Energía Nuclear (JEN)], and Empresa Nacional del Uranio S.A. (ENUSA). JEN was formed in the 1950s for the purpose of prospecting and exploring for uranium within Spain. ENUSA was originally created to exploit the uranium ore deposits in Spain discovered by JEN, but after the oil crisis in 1973, ENUSA's mission was extended to include the development of all nuclear fuel cycle activities. ENUSA is owned by the state-owned holding company Instituto Nacional de Industria (60 percent) and by CIEMAT (40 percent). ENUSA's responsibilities encompass uranium exploration, mining and milling, conversion, enrichment, and fuel fabrication. The company also is responsible for procuring fuel for all operating Spanish reactors.

Exploration for uranium resources in Spain began in the 1950s. JEN began regional reconnaissance operations of the sediments of the interior regions, and the igneous and metamorphic rocks of the mountainous areas. Approximately 40 prospective radiometric anomalies and mineral occurrences were located, and JEN selected the most favorable for further appraisal, including uranium deposits in the province of Salamanca.

RESERVES

Continuing uranium exploration efforts in the Salamanca province of west-central Spain have steadily increased the amount of known reserves, and by the end of 1990, over 79 million pounds U_3O_8 had been identified. About 80 percent of these reserves have been identified at a distance of less than 20 km from Planta Elefante, a heap leaching plant located near the village of Saelices el Chico. As radiometric, emanometric, and geochemical studies have indicated numerous anomalies, it is likely that estimates of uranium reserves will continue to increase.

In 1976, ENUSA decided to continue uranium exploration and research, and in 1981, was given the power to execute the National Uranium Exploration and Investigation Plan (Plan Nacional de Exploración e Investigación de Uranio - PNEIU), initiated by JEN in 1975. The activities of PNEIU were terminated in 1984. In 1986, the Department of Exploration (Departamento de Exploración) was created, with the primary objective of finding as many

© NUEXCO 1992

more reserves as those that were currently being exploited, as well as to complete the studies of all of the zones and anomalies in Salamanca province that had been identified before the activities of PNEIU were terminated. **Figure 1** shows the growth of identified Spanish reserves from 1976 through 1990.

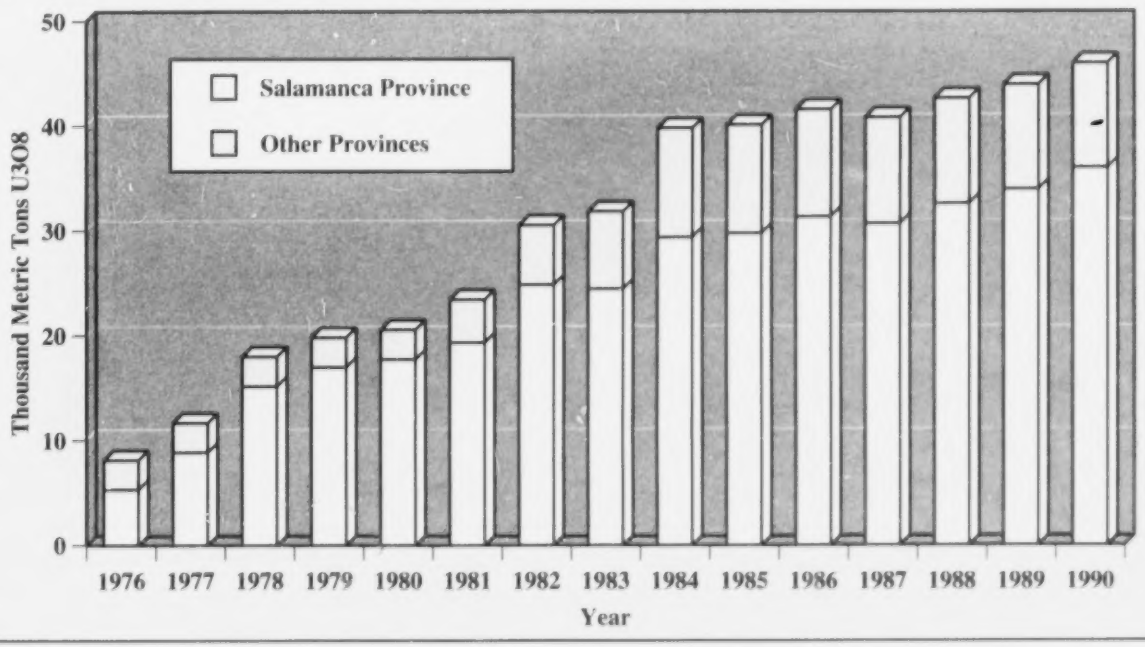
PRODUCTION

Spain's first full-scale industrial uranium production center started in 1959 at the General Hernandez Vidal uranium plant at Andujar, near the city of Jaén. The conventional processing plant had a capacity of about 440 thousand pounds of ore per day, and the total output equalled about 130 thousand pounds equivalent U_3O_8 annually. The plant was designed, constructed, and operated by JEN to process ore discovered in southern Spain in the Santuario de la Virgen de la Cabeza area, also close to Jaén, and at Cardena, near the city of Cordoba. Due to exhaustion of deposits, the plant was shut down in 1981.

Uranium mineralization was discovered in the vicinity of Saelices el Chico, in the province of Salamanca, during the early 1960s. In the late 1960s, JEN began testing ore from these deposits at a heap leaching pilot plant, and designed a commercial plant based on the results. ENUSA began the exploitation of the FE deposit at Saelices el Chico in July 1974. The Planta Elefante heap leaching plant was built near the main deposit, and brought into operation by ENUSA in May 1975. An expansion program, known as the Quercus project, is underway at the site, with a new processing plant due to start up in 1993.

None of ENUSA's deposits in the Salamanca province are amenable to underground exploitation because of the erratic geometry of the mineralization, but because of the FE deposit's shallowness, it is being exploited as an open pit (**Figure 2**). However, the deposit requires the exploitation of short benches (6 meters), which improves selectivity, but increases the cost of production.

Figure 1
SPAIN'S IDENTIFIED URANIUM RESERVES – 1976-1990



© NUEXCO 1992

Figure 2 — Open-Pit Mine at the Saelices el Chico Uranium Project. A photograph over the Agueda River, just following dynamite blasting at the FE deposit. (*Photo courtesy of ENUSA*)

La Haba Facility

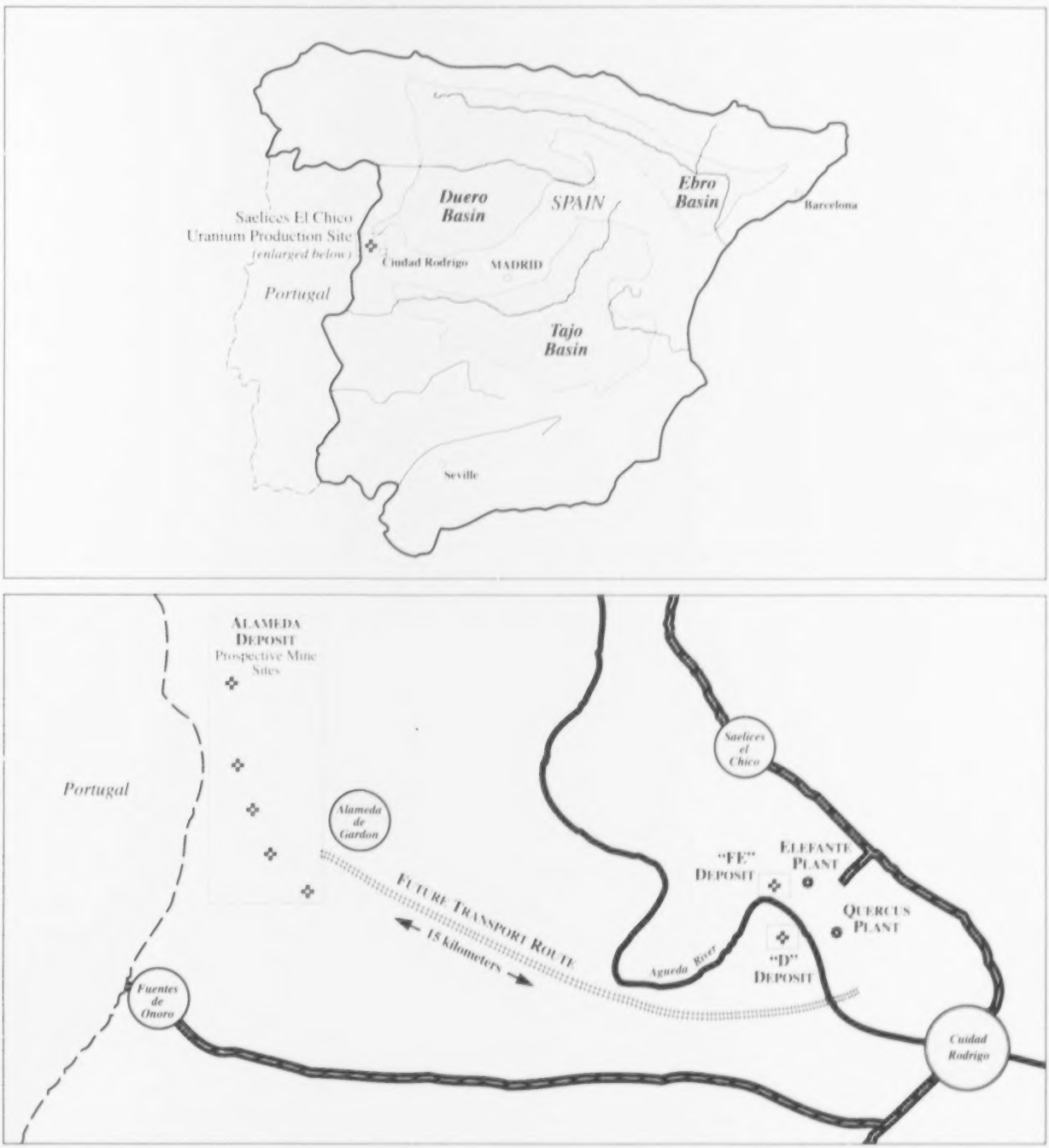
An experimental production facility previously existed in the area of La Haba near the city of Badajos. There was an open pit mining operation and also a processing plant (Lobo-G), which used a combination of agitated and heap leaching to produce a nominal capacity of 70 thousand pounds equivalent U_3O_8 per year. The facility began production in February 1983, but due to a combination of high production costs, increasing waste-to-ore ratios, and the difficulties experienced in extracting uranium from this ore, continued operation of the facility was deemed uneconomic, and the La Haba facility was closed in 1990.

Saelices el Chico Project

Spain's strategy for long-term uranium procurement is to increase the portion of requirements covered by domestic uranium production. Spain's only commercially active mine and processing plant are located in the area of Saelices el Chico. The area around Saelices el Chico is relatively flat and is traversed by the Rio Agueda. The uranium production center is located eight kilometers northwest of the town of Ciudad Rodrigo, about 90 km southwest of the city of Salamanca (the capital of the province), and about 260 km west of Madrid (**Figure 3**). The facility has a nominal production capacity totalling 550 thousand pounds equivalent U_3O_8 per year and has been

© NUEXCO 1992

Figure 3
LOCATION OF GEOLOGICAL BASINS AND SAELICES EL CHICO URANIUM PROJECT



© NUEXCO 1992

Spain's main uranium production center since it began production in 1974. **Figure 4** shows annual and cumulative U_3O_8 production from the project from 1975 through 1991. Production from the facility totalled nearly 600 thousand pounds equivalent U_3O_8 in 1991.

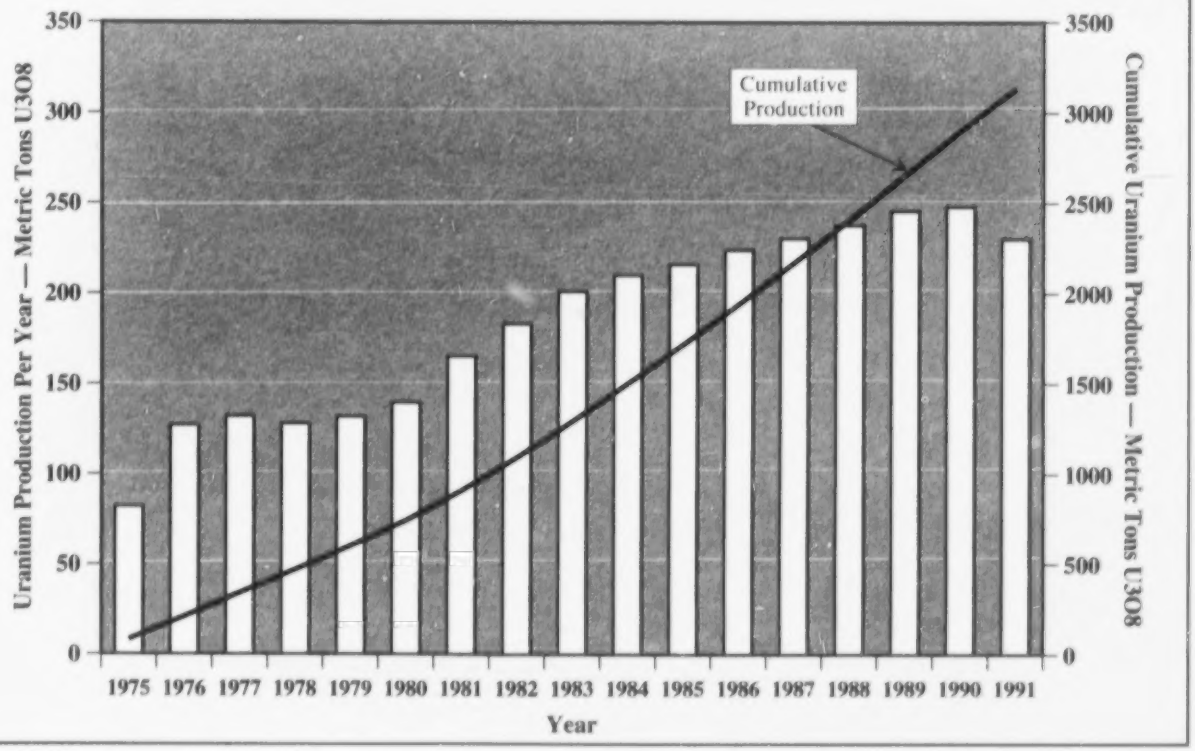
Due to the irregular nature of the veins, grade control and selective mining are important techniques in maintaining an acceptable mill feed grade. Drill holes for blasting are carefully monitored radiometrically, and samples are tested chemically. The ore is classified as either marginal or rich by a .06 % U_3O_8 cut-off point, and material under .02 % U_3O_8 is removed as waste. **Table 1** shows the portions of marginal and rich material produced at the Saelices el Chico facility from 1974 through 1991.

Front-end loaders with capacities of 2.5 to 4.5 cubic meters are used to load 35-tonne trucks. The marginal and rich ore is trucked to a crushing facility, and waste is taken to a dump where any seepage is collected for further processing. This seepage often contains uranium that has been naturally dissolved through bioleaching. The ore is crushed to sizes less than 100 mm and stacked in large rectangular piles for heap-leaching (**Figure 5**). The crushed ore then is bathed in an acid solution to extract the resident uranium.

Saelices el Chico Expansion

ENUSA is currently expanding the Saelices el Chico production facility. In December 1986, in accordance with the 1984 National Energy Plan (Plan Energético Nacional - PEN), ENUSA submitted a feasibility study to the National Institute of Industry (Instituto Nacional de Industria - INI) for the exploitation of deposits near Ciudad Rodrigo and construction of a new processing plant. In May 1987, INI authorized the investment, and in December 1987, ENUSA presented the application for construction of the project to the Ministry of Industry in

Figure 4
ANNUAL AND CUMULATIVE URANIUM PRODUCTION FROM THE SAELICES EL CHICO PROJECT



© NUEXCO 1992

Table 1
SAELICES EL CHICO URANIUM PROJECT—HISTORICAL PRODUCTION

Year	1974[1]	1975[2]	1976	1977	1978	1979	1980	1981	1982
					Metric Tons Mined				
Waste	194,265	553,585	1,076,015	2,101,164	2,778,204	2,908,609	3,563,238	1,654,995	1,473,170
Uranium Ore	65,114	196,115	214,531	247,353	370,021	430,589	436,950	333,088	386,563
– Rich[3]	23,384	70,003	89,559	124,690	136,028	136,642	133,869	115,919	118,809
– Marginal[4]	41,730	126,112	124,932	122,663	233,993	293,947	303,081	217,169	267,754
					Kilograms equivalent U_3O_8 Produced				
Concentrates	——	82,000	127,053	132,000	128,000	131,760	139,619	165,201	182,953

Year	1983	1984	1985	1986	1987	1988	1989	1990	1991
					Metric Tons Mined				
Waste	1,813,948	2,224,622	2,290,776	2,567,797	2,772,390	2,487,504	2,793,156	3,405,348	5,001,904
Uranium Ore	453,938	402,510	391,297	375,795	366,962	290,914	407,113	409,729	503,566
– Rich	129,976	133,178	109,918	103,575	110,046	107,797	99,044	85,406	86,929
– Marginal	323,962	269,332	281,379	272,220	256,916	183,117	308,069	324,323	416,637
					Kilograms equivalent U_3O_8 Produced				
Concentrates	200,984	210,032	216,017	223,945	230,303	237,693	245,595	248,001	230,007

[1] Exploitation of the FE deposit began in July 1974.
[2] The Elefante Plant was brought into operation in May 1975.
[3] Rich uranium ore is greater than or equal to 0.06 % U_3O_8.
[4] Marginal uranium ore is greater than 0.02 % U_3O_8, but less than 0.06 % U_3O_8.

Salamanca province (Delegación Provincial del Ministerio de Industria en Salamanca). The project will require a capital expenditure of approximately US$76 million, half of which is being funded by a grant obtained in December 1989 from the European Regional Development Fund. This funding ensures the economic viability of the expansion project, in spite of the current market price for uranium concentrates.

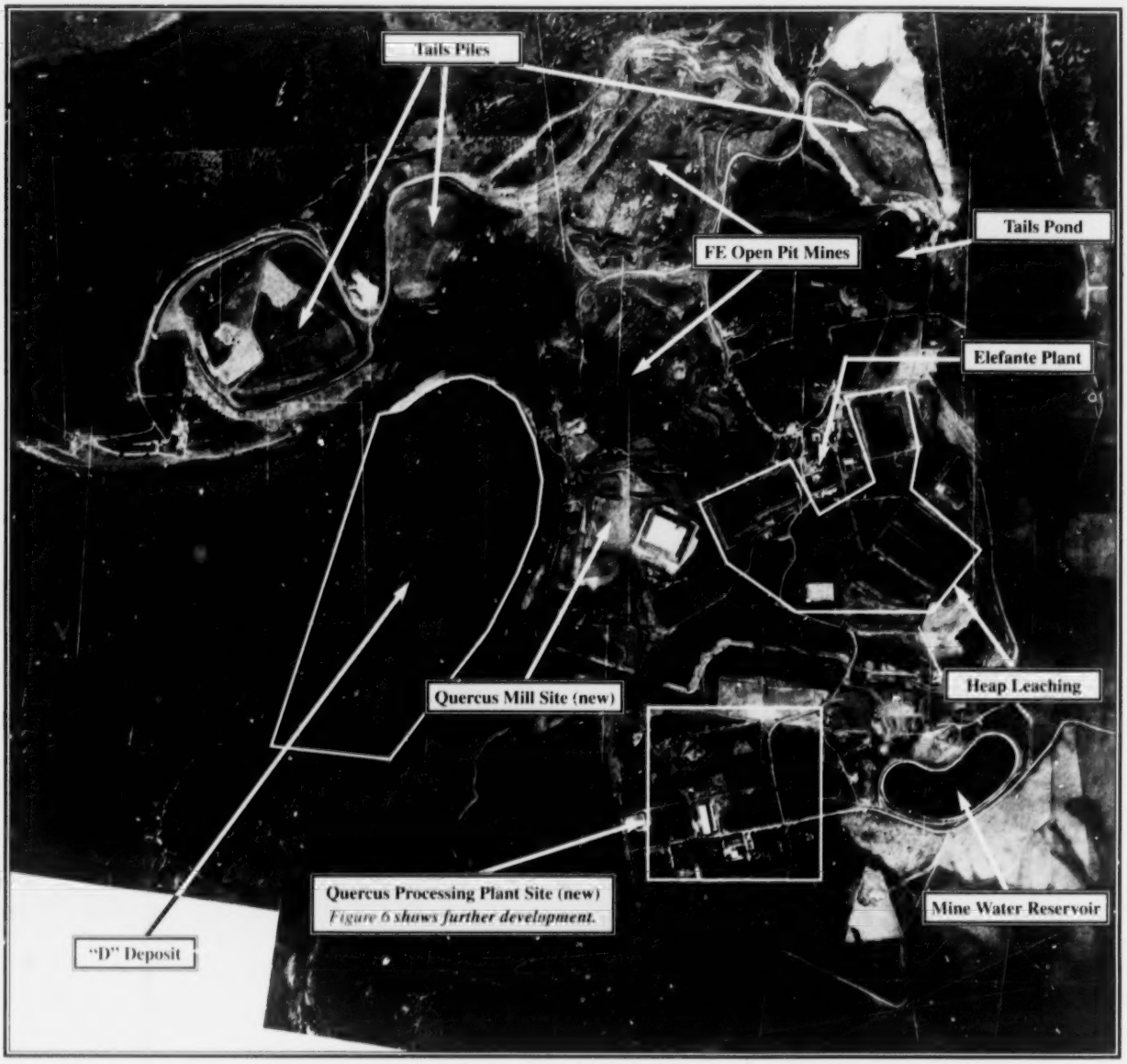
The Quercus expansion project includes the construction of a conventional mill to replace the current heap leaching process (**Figure 6**). When the project is completed in 1993, ENUSA will be able to supply the majority of Spain's uranium requirements from domestic mining. The source of ore will be the Iberian schists located in the FE, D, and Alameda deposits, all located on the southwest edge of the Duero Basin. Mining will continue as an open pit operation. The processing plant will process one-third of the ore using agitated leaching technology, and the remaining two-thirds using heap leaching. This plant is based on the experience gained from the operation of the Elefante and Lobo-G plants and the results of numerous tests on the ore of the FE deposit. The plant optimizes process yields by using different processing techniques for different feed grades. The new plant will be able to process up to two billion pounds of ore per year, with a nominal production capacity of approximately 2.1 million pounds equivalent U_3O_8 per year.

GEOLOGY

Important uranium mineralization was discovered by JEN in at least three separate basins: the Duero Basin, the Ebro Basin, and the Tajo Basin (**Figure 3**). These tertiary basins represent a total area of approximately 100 thousand

© NUEXCO 1992

Figure 5
SAELICES EL CHICO URANIUM PROJECT—COMPOSITE AERIAL PHOTO



square kilometers; each was considered to be geologically favorable for uranium mineralization. The largest, the Duero Basin, is surrounded by the Cantabrian Mountains on the north, the Central Iberian Zone on the west and south, and the Iberian Chain on the east. The Ebro Basin is situated between the Iberian and Pyrenees Mountain Chains. The Tajo Basin extends southward about 130 miles from Madrid, to the northern extremity of the Betic Mountain Chain, and is limited to the west by the Central Iberian Zone.

© NUEXCO 1992

Figure 6 — Quercus Uranium Processing Plant Construction. Part of the expansion program at the Saelices el Chico Uranium Project. (*Photo courtesy of ENUSA*)

Spain's most important uranium deposits are not typical, not only in the European environment (with the exception of some mineralization in Portugal), but also globally. While most uranium deposits are found in sedimentary rocks, ENUSA's main deposits are found in metamorphic rocks. The properties identified by JEN were transferred to ENUSA for exploitation in 1973, and were estimated to contain approximately 13 million pounds equivalent U_3O_8 at an average ore grade of 0.10 % U_3O_8.

The most important uranium region is in Salamanca province, which includes the southwest corner of the Duero Basin. Salamanca's reserves are found as disseminations within the contact metamorphic aureoles, where Hercynian granites, found primarily in the western regions of Spain, have invaded pre-Devonian shales. This type of deposit

© NUEXCO 1992

is commonly referred to as an Iberian schist. The uranium mineralization commonly occurs in igneous and metamorphic rocks of the Paleozoic sequence.

As a result of regional tectonics, dating back as far as 350 million years, intervening low-lands were uplifted to form the high plateaus that are common throughout the Spanish interior. The plateau regions, known as mesetas, experienced continuing transformation through heavy erosion and structural subsidence well into Tertiary times. The mesetas collected varying thicknesses of coarse to fine Tertiary sediments. The source of the sedimentary material was the older rocks which eroded from the surrounding mountains. The Early Tertiary sediments filling the basins and the deeper Triassic and Jurassic rocks are considered favorable hosts for uranium mineralization.

The Iberian Meseta, which extends into the Salamanca province, has two structural blocks—a northern and a southern block. The northern block hosts a number of uranium deposits, whereas the southern block, composed predominantly of marine Upper Devonian and Carboniferous slates and greywackes, lacks granite intrusions and uranium deposits.

Two-thirds of the northern block is part of the Central Iberian Zone, which is composed essentially of a very thick sequence of weakly metamorphosed flysch-type schists and greywackes, probably of Upper Proterozoic and Lower Cambrian age. The southern third of the northern block is named the Ossa Morena Zone, and is widely underlain by Cambrian, Ordovician, and Silurian sediments and metasediments. Some acidic and basic volcanics are present in most stratigraphic units. During the Hercynian Orogeny, the northern block was folded along a NW-SE axis and extensively faulted and intruded by granites.

MINERALIZATION

The Ciudad Rodrigo uranium district, in Salamanca province, is located within the eastern section of the Iberian Meseta. The FE deposit is the principal uranium deposit being exploited by the Saelices el Chico production center in the Ciudad Rodrigo uranium district. The FE deposit occurs as a mineralized stockwork of veinlets within pelitic schists of Silurian and Cambrian age. The mineralization within the deposit consists principally of secondary uranium minerals such as autunite, uranotile, phosphuranylite, and torbernite. Pitchblende is the primary mineral. Pyrite is the main accessory mineral, although calcium carbonate is also common. The quantity of these accessory minerals is small, thus they do not cause problems during acidification treatment.

About 90 percent of Spain's ore reserves occur in Iberian schists. Secondary uranium minerals have concentrated on fracture surfaces in a zone 30 to 50 meters thick. The mode of mineralization resembles a typical enrichment blanket, whereby the slates above and below the blanket are almost completely barren of uranium. The pre-Devonian strata above and below the slate consists of alternating carbonaceous beds and quartzitic conglomerates, of which none are mineralized. The remaining ten percent of mineralization occurs as primary uranium minerals (pitchblende and coffinite) in veins and fractures within Hercynian granites.

The most important uranium deposits in Spain are found in Cambrian-Precambrian slates. Some of these deposits are located near the contact of the slates against Hercynian granites, with some of the mineralization reaching the granite. The primary mineral of these deposits is pitchblende, generally appearing in a network of deep breccias without a predominant direction.

CONCLUSION

Although the future of the nuclear industry in Spain remains uncertain, ENUSA is in the process of expanding the Saelices el Chico uranium production center. As Spain's strategy for long-term uranium procurement is to increase the portion of requirements covered by domestic uranium production, a reversal of the government's nuclear moratorium policy could lead to an even more rapid expansion of domestic production. Even if this occurred, Spain's known uranium reserves, and its advanced production facilities, will be able to supply most of the country's requirements well into the future.

Michael P. Ferguson

© NUEXCO 1992

INDIA'S NUCLEAR PROGRAM

India made an early commitment to being as self-sufficient as possible in nuclear energy and has largely achieved that goal. The country operates eight nuclear reactors with a total capacity of 1,304 MWe, and it remains committed to an aggressive growth plan for its nuclear industry, with six reactors currently under construction, and as many as twelve more planned. India also operates several heavy water production facilities, fabrication facilities, reprocessing works, and uranium mines and mills. Due to India's decision not to sign the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), the country has had to develop nearly all of its nuclear industry and infrastructure domestically. Overall, India's nuclear power program is self-contained and well integrated, with plans to expand to provide up to ten percent of the country's electrical generating capacity.

NUCLEAR POWER PROGRAM

Background

India's nuclear power program has at its roots the Tata Institute of Fundamental Research, founded in 1945 to carry out research in the field of atomic energy. The next major step was the passage of India's Atomic Energy Act in 1948. The Act outlined a specific atomic energy program for the country and established the Atomic Energy Commission (AEC), which is responsible for formulating policies for the Department of Atomic Energy (DAE) and preparing its budget, as well as ensuring the implementation of government policies regarding atomic energy. The AEC oversees all of India's activities related to nuclear power.

Since the mid-1970s, India's nuclear program has operated independently of the rest of the world's nuclear commerce. In 1963, India and the USA signed a 30-year nuclear cooperation agreement, in which the USA promised to provide enriched uranium fuel for US nuclear reactors then being considered for purchase by India. Following the signing of the agreement, India ordered two General Electric boiling water reactors (BWRs) that were built at Tarapur, and placed in operation in 1969.

In 1968 India refused to sign the NPT, claiming it was discriminatory in that its restrictions were not applied equally. Moreover, the 1974 explosion of what India termed a "peaceful" nuclear device strongly affected India's international political relations and its commercial nuclear power program. Prior to the 1974 explosion, Atomic Energy of Canada Ltd. (AECL) had been heavily involved in the Indian nuclear program, in design and construction of both research and power reactors. India had selected the CANDU technology for its third and fourth reactors (Rajasthan Units 1 and 2), in part because the natural uranium fuel used by the pressurized heavy water reactors (PHWR) would not require enrichment. For this reason, the fuel could be supplied largely from domestic sources, and therefore would not be subject to restrictions on its disposition after use in the reactor. Following the bomb test however, the Canadians stopped all assistance, cancelling the supply of equipment for the Rajasthan units and essentially terminating nuclear cooperation with India. Under Indian guidance alone, the Rajasthan units were eventually completed, although after considerable delay.

In 1977, the US Government announced its dissatisfaction with its 1963 bilateral cooperation agreement with India, a situation aggravated by India's refusal to accept full-scope IAEA safeguards for the country's nuclear facilities. In 1978, the US Congress passed the Nuclear Non-Proliferation Act (NNPA), tying US exports of nuclear fuel and equipment to the conclusion of new bilateral safeguards agreements, and leading to a dispute between the USA and India regarding the remaining fuel deliveries specified under the 1963 pact.

In the fall of 1980, President Carter approved a final delivery of US enriched uranium fuel to be made to Tarapur. Between 1981 and mid-1983, with political relations between India and the USA showing considerable strain and the fuel dispute still unresolved, the Tarapur units were forced to operate at less than half of capacity. By late 1982, a partial solution was agreed upon, in which France would assume US obligations to provide India with fuel, totalling approximately 20,000 kgU as UF_6 enriched to approximately 2.7 w/o ^{235}U. The first French delivery was made in May 1983.

© NUEXCO 1992

Also in the early 1980s, US export of nuclear spare parts to the Tarapur plant became a controversial issue, as the US Congress viewed such export sales as a violation of the NNPA. Considering India's nuclear test and its refusal to allow indefinite inspections of Tarapur, the US Nuclear Regulatory Commission denied GE and several subcontractors export licenses for plant equipment. Eventually, India either procured most of the required spare parts from European suppliers or fabricated the parts domestically.

The issue of India's reprocessing rights and safeguards has not subsided. Most of the country's nuclear program is not covered by any international safeguards agreements, having been built and fueled to a large extent indigenously. India steadfastly maintains that all of its plutonium resources are, and will be, used for peaceful projects, such as the fueling of the fast breeder reactors planned for the next century. In developmental terms, India's unwillingness to conform to international safeguards conventions drastically limits its access to nuclear technology worldwide.

Nuclear Power Strategy

India's nuclear power program is comprised of three stages; the first stage originally was planned to provide 10,000 MWe of installed capacity by the year 2000. In addition to the reactors already built or under construction, this first stage called for construction of twelve more 235-MWe PHWRs, and ten 500-MWe PHWRs, bringing total capacity to more than 10,000 MWe and providing an estimated ten percent of the country's total generating capacity. However, in August 1991, AEC Chairman Dr. P. K. Iyengar announced that due to financial constraints, the goal had been reduced to 9,000 MWe by the year 2000, including 2,000 MWe of capacity from Soviet-supplied VVERS. Since those VVER reactors have since been cancelled, the revised goal is now 7,000 MWe.

The second stage of the country's nuclear plan is to develop commercial fast breeder reactors. While India is actively conducting research and development in this area, progress has been slow. The government continues to support these efforts but has stated that the 40-MWt fast breeder test reactor (FBTR) at Kalpakkam must demonstrate it can operate successfully before additional funding for a 500-MWe prototype FBR will be granted.

The breeder reactor development of the second stage is critical for stage three. India has the largest thorium-232 deposits in the world. The third stage of the country's long-term plans is to utilize this domestic source by using it as a blanket in breeder reactors and converting it into uranium-233. However, these plans are scheduled well into the next century, and most of the country's efforts are now focused on the immediate need for power that additional PHWRs can provide.

Operating Stations

India's first reactors, two GE-supplied 150-MWe BWRs, located at Tarapur about 100 km north of Bombay, began commercial operation in October 1969. Since that time, India's Nuclear Power Corporation (NPC), a public limited company under DAE responsible for operating reactors in the country, has brought six 220-MWe PHWRs on line. This includes Narora 2, which reached criticality in December 1991, and is expected to reach commercial operation later this year. During 1991, the seven reactors operating commercially throughout the year generated 5,105 GWh of electricity with an average capacity factor of 45 percent (**Table 1**). This accounts for almost three percent of all electricity generated in India.

The BWRs at Tarapur are India's only reactors built on a turn-key basis by non-Indian contractors. The two reactors were built in five years, and had about 30 percent Indian participation in the project. The AEC's strategy has been to build the country's nuclear program based on the PHWR design, but the AEC recognized it would be effective to gain experience in the construction and management of nuclear power plants by working with outside contractors on the country's first nuclear station. This strategy also would result in faster construction times required to address the country's energy shortage.

While the BWR station has had difficulties historically (e.g., securing spare parts and enriched fuel), overall the plant has performed fairly well. In 1991, units one and two achieved 61 percent and 67 percent capacity factors, respectively. Together, the two units have generated more than 40 billion kWh during their lifetimes. Last fall, the Department of Atomic Energy approved a Plant Life Extension program for the station. Studies have already

© NUEXCO 1992

Table 1
NUCLEAR POWER UNITS IN INDIA

Units In Operation

Unit	Lead Utility or Fuel Buyer	Capacity (MWe net)	Type	COD [1]	1991 Capacity Factor (percent)	Total 1991 Electricity Generation (GWh net)
Kalpakkam 1 (MAPS)	NPC [2]	175	PHWR	1984	36	552
Kalpakkam 2 (MAPS)	NPC	175	PHWR	1985	76	1,169
Narora 1 (NAPS)	NPC	220	PHWR	1991 [3]	28	545
Rajasthan 1 (RAPS)	NPC	207	PHWR	1973	12	226
Rajasthan 2 (RAPS)	NPC	207	PHWR	1981	51	933
Tarapur 1 (TAPS)	NPC	150	BWR	1969	61	806
Tarapur 2 (TAPS)	NPC	150	BWR	1969	67	874
TOTAL		**1,284**		*(1991 Average:*	**45)**	**5,105**

Units Under Construction and Planned

Unit	Lead Utility or Fuel Buyer	Capacity (MWe net)	Type	COD [1]	Percent Complete [4]
Kaiga 1	NPC	220	PHWR	1995	40
Kaiga 2	NPC	220	PHWR	1996	40
Kakrapar 1 (KAPP)	NPC	220	PHWR	1993	89
Kakrapar 2 (KAPP)	NPC	220	PHWR	1994	89
Narora 2 (NAPP)	NPC	220	PHWR	1992	100
Rajasthan 3 (RAPP)	NPC	220	PHWR	1995	31
Rajasthan 4 (RAPP)	NPC	220	PHWR	1996	31
Rajasthan 5 (RAPP)	NPC	470	PHWR	——	planned
Rajasthan 6 (RAPP)	NPC	470	PHWR	——	planned
Rajasthan 7 (RAPP)	NPC	470	PHWR	——	planned
Rajasthan 8 (RAPP)	NPC	470	PHWR	——	planned
Tarapur 3 (TAPP)	NPC	470	PHWR	2000	planned
Tarapur 4 (TAPP)	NPC	470	PHWR	2001	planned
Trikkareppur 1	NPC	470	PHWR	——	planned
Trikkareppur 2	NPC	470	PHWR	——	planned
Trikkareppur 3	NPC	470	PHWR	——	planned
Trikkareppur 4	NPC	470	PHWR	——	planned
Trikkareppur 5	NPC	470	PHWR	——	planned
Trikkareppur 6	NPC	470	PHWR	——	planned
Trikkareppur 7	NPC	470	PHWR	——	planned
Trikkareppur 8	NPC	470	PHWR	——	planned
TOTAL		**8,120**			

[1] COD = Commercial Operation Date (actual or expected)

[2] NPC = Nuclear Power Corporation (Department of Atomic Energy)

[3] Source: NPC—Contrary to other sources, NPC stated that Narora 1 was declared in commercial operation on January 1, 1991. As the plant operated effectively for the full year, a capacity factor is shown and its generation is included in calculation of the 1991 Average Capacity Factor.

[4] Source: *Nuclear News*. Construction progress as of December 31, 1991.

© NUEXCO 1992

begun on extending the life of the plants by 20 years, and preliminary results indicate that the extension is both economically and technically feasible. Additional studies are on-going, and station managers must submit a life extension application to India's Atomic Energy Regulatory Board by 1998.

India's second nuclear power station was built at Rana Pratap Sagar Lake, 64 km southwest of Kota, in the state of Rajasthan. The Rajasthan Atomic Power Station (RAPS) contains two 207-MWe PHWRs of the CANDU type, designed by AECL. Unit 1 began commercial operation in 1973, and Unit 2 was commissioned in 1981. Unit 1 has had a difficult operating history: the lifetime capacity factor for the plant is only 22 percent. Initially, the plant was connected to an unstable electrical grid that had only a 500-MWe capacity. Consequently, any disturbance in the grid frequency often caused disturbance in the station process system, leading to frequent reactor tripping and severe strain on station equipment. The most severe problem was first discovered in September 1981 when cracks developed in the end shield of the reactor vessel. Various methods were used to try to repair the cracks, but the reactor was essentially shut down until February 1985. The reactor was restarted, but operated for only three months before new cracks appeared. Finally, the cracks were repaired by August 1987 using mechanical plugs and graphoil gaskets. The unit was restarted and continues to operate, but is limited to 50-percent power to prevent further cracks.

Completion of Unit 2 was delayed until 1981, due to Canada's withdrawal of nuclear assistance following India's "peaceful" nuclear explosion. From lessons learned in the operation of Unit 1, the AEC incorporated several improvements into Unit 2, and the second unit has operated satisfactorily with a lifetime capacity factor of 59 percent. The maximum output of Unit 2 also has been limited, although to a lesser degree than Unit 1. The reason for the limitation is that the average temperature of the cooling water source at RAPS is 28°C—seven degrees warmer than AECL's design basis—thereby limiting the plant's production to about 86 percent of its maximum designed output, due to condenser vacuum limitations. In 1991, Unit 2 generated 933 GWh (net) at an average capacity factor of 51 percent.

The Madras Atomic Power Station (MAPS) located at Kalpakkam in Tamil Nadu state is almost all domestically supplied. Over 85 percent of the twin 175-MWe PHWR station was provided by Indian sources. Both reactors had an original design basis of 235-MWe (gross), slightly larger than the designed capacity at RAPS. But due to failures in the coolant inlet manifolds in 1989, NPC had to redesign the coolant circuit, which led to downrating the plant's net capacity to 175 MWe. Unit 1 had a capacity factor of 36 percent in 1991, and Unit 2 achieved a 76 percent capacity factor.

India's newest nuclear station is located at Narora in Uttar Pradesh state in northern India (**Figure 1**). Unit 1, a 220-MWe PHWR, first reached criticality in March 1989, but was not declared officially in commercial operation until January 1, 1991. Unit 2 achieved criticality in late 1991, and is expected to be commissioned in 1992. These units, like the units at RAPS and those under construction, originally claimed a 235-MWe gross capacity rating, but operational experience, as well as limitations on the turbine generators, have led NPC to assess the gross sustainable capacity of the newer plants at 220 MWe each.

Units Under Construction

India's Nuclear Power Corporation also is responsible for construction of nuclear reactors in the country. NPC currently is overseeing construction of six reactors at three stations: Kakrapar 1 and 2; Kaiga 1 and 2; and Rajasthan 3 and 4. [Note—operating stations are called atomic power stations, such as RAPS, whereas facilities under construction are called atomic power projects, such as KAPP].

Construction at Kakrapar 1 is more than 90-percent complete, and initial criticality was planned for late 1991. However, in mid-October a fire occurred in the switchyard of the unit. Although causing only minor damage to non-nuclear components, the incident has delayed the initial criticality of the unit until mid-1992. Unit 1 is expected to reach commercial operation in 1993, and Unit 2, a twin 220-MWe PHWR, is expected to reach commercial operation one year later.

Like all of India's reactors under construction, Kaiga Units 1 and 2 are 220-MWe PHWRs. The station, located near the Arabian Sea in southwestern India, is more than 40-percent complete and is expected to reach commercial operation in 1996. NPC also has two more PHWRs under construction at its RAPS site. Rajasthan 3 and 4 are approximately 31-percent finished and planned for operation in 1996.

© NUEXCO 1992

Figure 1
NUCLEAR POWER STATIONS AND FUEL CYCLE FACILITIES OF INDIA

© NUEXCO 1992

Planned Reactors

In addition to the six PHWRs under construction, India has plans for twelve more. Two more PHWRs are planned for the Kaiga site, and two 500-MWe PHWRs have been approved for construction at Tarapur. The Indian government agreed in early 1991 to finance the units, and the projects already have been granted the necessary environmental, technological, and safety approvals.

In mid-1991, the AEC announced it had selected Trikkareppur in the state of Kerala as the future site of India's largest nuclear power station. When completed, the station will include eight 500-MWe units, with initial electrical production planned for 1997. However, much of the funding for the station was to come from the former Soviet Union, under an Indo-Soviet nuclear cooperation agreement. Although plans for the station are progressing, the construction schedule may be delayed considerably due to lack of funding.

The AEC also has been considering plans for four 500-MWe units at Rajasthan, although they are still in the formative stages. India had plans for two 1,000-MWe VVERs at Kudankulam, to be supplied by the Soviet Union. However, those plans have been cancelled, due to the dissolution of the Soviet Union.

FUEL CYCLE FACILITIES

Heavy Water Facilities

In support of its aggressive nuclear program that relies on PHWRs, India has developed significant heavy water production capacity. The country's first plant began operation in 1962 at Nangal with a capacity of 14 metric tonnes per year. A separate division of the Department of Atomic Energy known as the Heavy Water Board (**Figure 2**) oversees the construction and operation of all heavy water plants in the country.

Most of India's heavy water plants are operated in conjunction with fertilizer plants, using synthesis gas as feedstock in a bithermal ammonia-hydrogen exchange process. Other inputs obtained from the fertilizer plants are ammonia, steam, and nitrogen. The heavy water plants have been particularly affected by problems associated with their dependence upon the fertilizer plants, such as poor or intermittent electricity supply, and interruptions in supply of feedstocks and other necessary inputs. At Baroda and Tuticorin, the synthesis gas has at times also contained less than design levels of deuterium. Since efficient operation of the heavy water plants depends to a great extent on smooth, uninterrupted operation, such problems have caused production to be considerably reduced from rated capacity in some cases.

India currently operates seven heavy water plants. The facilities at Baroda, Nangal, Tuticorin, Talchar, and the newly commissioned plant at Hazira, are based on the ammonia-hydrogen exchange process. Due to power shortages to operate the electrolysis plant at Nangal, a new plant was built to generate pure hydrogen by naptha reforming and pressure-swing adsorption. The heavy water plant at Nangal now processes the feed gas from this unit, which has significantly improved its production. The plant at Kota uses the hydrogen sulfide-water exchange process. The other operational plant is located at Thal, in Maharashtra state; it produces heavy water using an ammonia-water exchange process. **Table 2** lists the operating plants and their capacities, and also includes the Manuguru plant in Andhra Pradesh that is in the final stages of construction. This plant will use a hydrogen sulfide-water (steam) process to achieve a planned capacity of 185 tonnes per year. It is expected to become fully operational later this year.

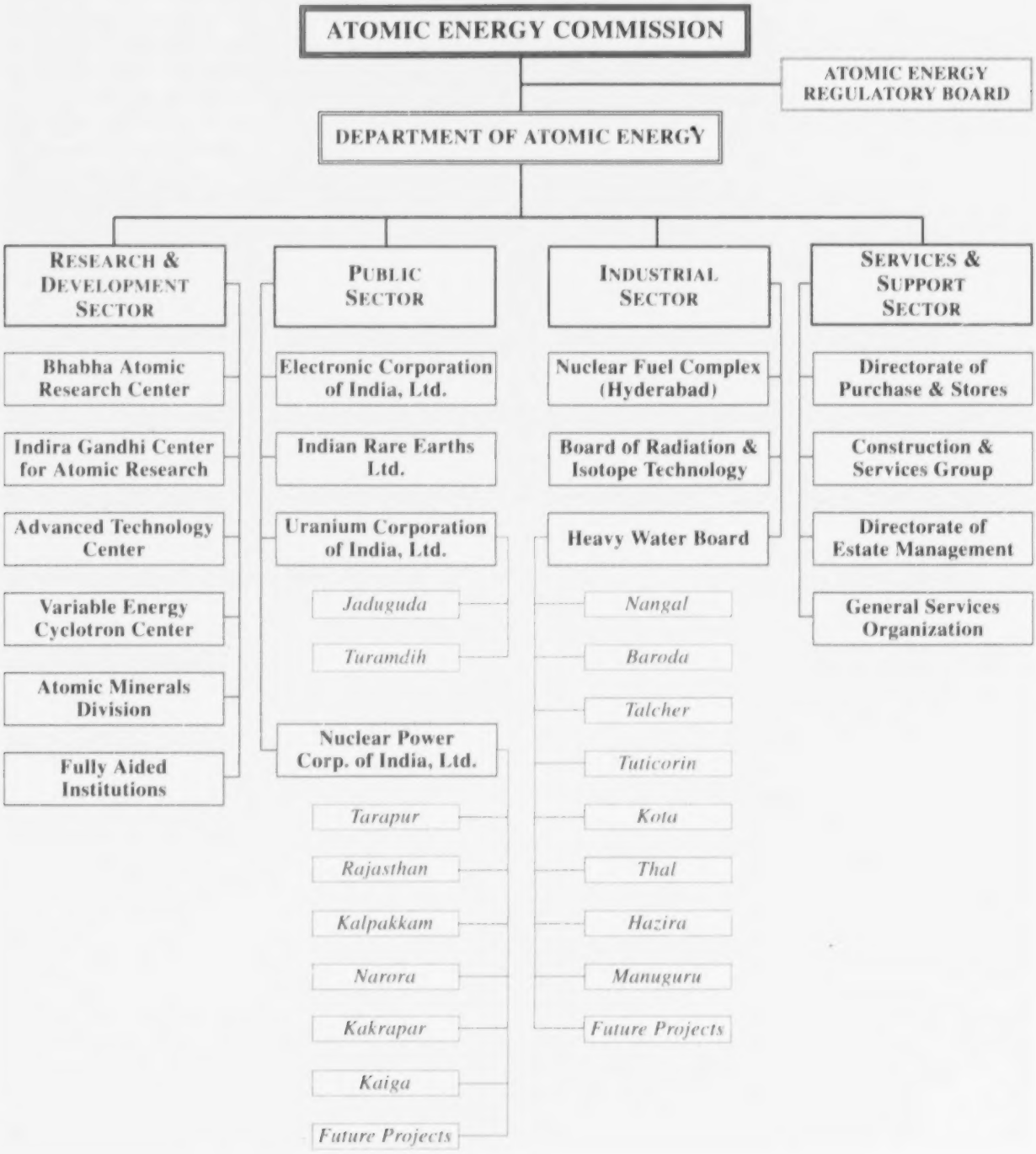
In addition to the plants that produce heavy water, the Department of Atomic Energy also has three heavy water upgrading plants at Kalpakkam, Kota, and Narora. These plants recover the tritium and refurbish the down-graded heavy water collected from operating reactors. Combined, the country's various heavy water facilities are sufficient to supply all the nation's requirements only if the heavy water plants operate well. As a result, India has set aside some funds to purchase heavy water internationally, when necessary.

Fabrication

India's overriding goal for its nuclear program is self-sufficiency throughout the fuel cycle. To this end, the country has developed a nuclear fuel complex at Hyderabad to fabricate fuel for all the nation's reactors. The complex produces natural UO_2 fuel bundles for the Rajasthan, Madras, and Narora stations, as well as enriched uranium fuel assemblies for the Tarapur BWRs. The facility also produces the core axial subassemblies and thorium blanket

© NUEXCO 1992

Figure 2
ATOMIC ENERGY COMMISSION ORGANIZATION CHART



© NUEXCO 1992

Table 2
INDIA'S HEAVY WATER PLANTS

Plant	Process	Capacity (tonnes/yr)	COD [1]
Baroda	ammonia-hydrogen	67	1980
Hazira	ammonia-hydrogen	110	1991
Kota	hydrogen sulfide-water	100	1981
Nangal	ammonia-hydrogen	14	1962
Talcher	ammonia-hydrogen	62	1980
Thal-Vaishet	ammonia-water	110	1987
Tuticorin	ammonia-hydrogen	71	1978
Manuguru	hydrogen sulfide-water	185	1992 [2]

[1] Commercial Operation Date (actual or expected)
[2] The Manuguru plant is in the final stages of construction, and is expected to be commissioned in 1992.

subassemblies for the FBTR at Kalpakkam. As part of its comprehensive fuel production capability, the complex also manufactures Zircaloy and zirconium-niobium alloys for fuel element cladding. Fuel also is fabricated at the Bhabha Atomic Research Center (BARC) near Bombay. That plant can produce up to 135 MT per year of PHWR fuel. At both facilities, PHWR fuel is made from magnesium diuranate, which is then converted into UO_2. Fuel for the BWRs at Tarapur is fabricated at the Hyderabad complex from imported enriched UF_6. Enriched fuel imported for use in the Western-constructed reactors is subject to international safeguards.

In mid-1991, the DAE announced plans to invest over seven billion rupees (US$270 million) during the next decade to build and expand its nuclear fuel production capability. Plans for the Hyderabad complex include increasing the UO_2 pellet production capacity from 350 metric tonnes per year to 660 MT per year; building a uranium fuel assembly plant with a 600 MT per year capacity; and commissioning a 150 MT-per-year Zircaloy fabrication plant. All three of these facilities are scheduled for completion by 1994.

The Department also plans to build a 300 MT-per-year zirconium sponge plant at Palayakayal in Tamil Nadu. The two billion rupee plant will produce reactor-grade zirconium and is scheduled for completion in 1994. All four of these new projects have received the necessary regulatory, technical, and environmental approvals.

Reprocessing

Reprocessing of spent fuel takes place at several facilities. India's first reprocessing plant was built at the BARC complex in Trombay and was commissioned in 1964 with a capacity of about 30 tonnes per year. The Indian-designed and built plant uses the Purex process with solvent extraction columns. Fuel reprocessed at BARC comes mainly from the Cirus 40-MWt, heavy water moderated, research reactor located at the Center.

The primary reprocessing plant in India is known as the PREFRE facility, located near the Tarapur reactor site. Commissioned in 1982, the 100 tonne-per-year facility has reprocessed fuel from the Tarapur, Rajasthan, and Madras reactors, as well as plutonium destined for use in the FBTR. This plant operates under international safeguards only when reprocessing safeguarded material, such as enriched UF_6 imported from France. When reprocessing domestic fuel material, no such safeguards apply to its operation.

The plant has been used very infrequently since its start up. AEC Chairman Iyengar indicated earlier this year that the amount of fuel reprocessed is well below the capacity of the plant, and that only twice has a series of unsafeguarded material from the Madras station been reprocessed. This Madras material has produced enough plutonium to manufacture two cores for the FBTR at Kalpakkam.

India also is about to complete a new plant at Kalpakkam for reprocessing spent Zircaloy-clad UO_2 fuel. The 125 MT-per-year facility is scheduled to go into hot operation late this year. As a result, the PREFRE facility will be used only occasionally for reprocessing safeguarded material from Tarapur. Any other reprocessing will be completed at the new Kalpakkam facility. India does not plan to build a single large reprocessing complex like those in France or Japan, but rather will build smaller facilities, as demand requires, at locations near the country's reactors.

India announced in mid-1991 that it is offering to reprocess foreign spent fuel from research reactors of other

© NUEXCO 1992

countries. India will require that the fuel be subject to IAEA safeguards and that the wastes from the reprocessing process must be shipped back to the country of origin. The offer is part of India's larger effort to export nuclear technology and consultant services abroad, particularly in the area of small research reactors.

Waste Management

India operates low- and intermediate-level waste management facilities at Trombay, Tarapur, Rawatbhatta (Rajasthan), and Narora. These plants process the wastes generated from the nearby nuclear stations. The DAE also operates a facility near the Tarapur complex to process high-level wastes. In 1990, the Waste Immobilization Plant (WIP) at Tarapur successfully vitrified waste from the PREFRE reprocessing plant, and research continues in this area to allow vitrification of wastes with higher specific activity. As part of its interim storage plans, the DAE also is developing an away-from-reactor spent fuel storage facility at Tarapur and another WIP facility at Trombay. India has done some preliminary work in identifying a long-term waste disposal site, but no particular location has been selected yet.

URANIUM INDUSTRY

India maintains a large, on-going uranium exploration program to meet the country's domestic nuclear fuel requirements. Exploration, mining, and milling of uranium and thorium takes place under the auspices of the DAE. One of the first institutions started under the DAE was the Atomic Minerals Division (AMD), which operates regional centers for exploration and research. The state-owned Uranium Corporation of India, Ltd. (UCIL) and India Rare Earths, Ltd. conduct production operations for uranium and thorium, respectively.

India's known reserves of uranium are not particularly large, estimated by OECD/IAEA to total 64,600 metric tonnes of uranium (MTU). Of these, about 41,100 MTU of Reasonably Assured Resources are in the under $80/kg category, about 6,200 tonnes are in the $80-130/kg category, and 17,300 tonnes are classified as Estimated Additional Resources. The major focus of uranium exploration and development has been in the Singhbhum thrust belt, west of Calcutta in the state of Bihar. The AMD also has expanded its exploration efforts outside this area in recent years. In 1991, this expanded search effort paid off: the DAE announced late in the year that it had located a major uranium deposit at Domiasat in northeast India in the state of Meghalaya. The sandstone-type deposit is the largest and richest deposit yet discovered in India. It covers an area of more than ten square kilometers, ranging in depth from 5 to 50 meters, with ore grades as high as 0.41 % U_3O_8.

Jaduguda

Within the Singhbhum district, UCIL manages its sole operating uranium mining and milling facility at Jaduguda. The Jaduguda mine was one of the first mines to have been developed indigenously by India. The first stage of mine development was sinking a main shaft 315 meters deep. This was completed in 1968 and also marked the start of production from this underground mine. Stage two was completed in 1977; it opened up new mining areas below 300 meters and extended the main shaft down to 640 meters in depth. All ore now produced from this mine comes from below the 300-meter level.

The third stage of this mine's development is to sink another shaft, from 555 meters to 900 meters deep. The Indian government has approved the 1992 budget for UCIL to begin sinking this shaft. The new shaft is expected to be complete by 1994, and any additional production from this mine in the upcoming decade will come from the depths accessed by this new shaft.

The Bhatin mine is located about three kilometers from Jaduguda. It is a small underground mine that can produce about 250 tonnes of ore per day, although at relatively low grade. Ore is transported daily by truck to the Jaduguda mill.

The Jaduguda mill was commissioned in 1968 and processes primary ores from the Jaduguda and Bhatin mines. Between five and ten percent of the uranium processed at the mill comes from uranium mineral concentrates recovered from copper tailings of the Surda, Mosaboni, and Rakha copper mines. Ore from the nearby uranium mines is crushed, ground, and leached with sulfuric acid. The pregnant solution is then filtered and precipitated in the form of magnesium diurinate. The yellowcake is then packed in drums and sent to the nuclear fuel complex at Hyderabad for processing into nuclear fuel. The mill produced near its capacity in 1991, with an output of approximately 550 thousand pounds equivalent U_3O_8.

© NUEXCO 1992

Turamdih

The other important uranium project in India is the mining and milling facility being developed at Turamdih. The project is also in the Singhbhum district, about 25 kilometers west of Jaduguda. Two conventional mines, named Turamdih and Narwapahar (about 13 km from Turamdih) are being developed. When completed in the mid-1990s, each mine will be capable of producing 1,500 tonnes of ore per day at an average grade of 0.04 % U_3O_8. The mining method is expected to be the same as Jaduguda: cut and fill, with the mined out stopes backfilled with deslimed mill tailings. The tailings would be directed into the stopes through drill holes from the surface.

UCIL has been allocated 320 million rupees (US$11.4 million) in the FY1992 budget for development of the two mines and the mill at Turamdih. The mill's planned capacity is almost one million pounds U_3O_8 annually, and output from the mill is projected at around 750 thousand pounds U_3O_8 per year. Production from this project is expected to begin in the mid- to late-1990s, as production from the Jaduguda facility is phased out.

CONCLUSION

India maintains one of the world's most aggressive plans for growth of its nuclear industry. Because of safeguards issues, the country has had to develop all of its fuel cycle domestically, slowing its progress. Nevertheless, the country's accomplishments in the nuclear field are remarkable. The Department of Atomic Energy remains committed to building more PHWRs and additional heavy water facilities, and to developing a fast breeder reactor program that will capitalize on the country's vast thorium deposits. Efforts now are focused on improving the performance of the country's reactors and heavy water plants, and on further identifying and developing its uranium deposits.

While India's nuclear power development will continue to be hampered by its refusal to sign the NPT, the recent signing of the treaty by China and France, and offers to negotiate a nuclear-weapons-free zone by Pakistan, make it likely that India will at least reconsider its safeguards position in upcoming years. Meanwhile, the country continues to expand its nuclear program in order to provide the immense amount of power required as the nation develops.

© NUEXCO 1992

NUCLEAR INDUSTRY CALENDAR

1992

May 17-19 ***19th Annual Meeting & Int'l Conference on Nuclear Energy*** (Hotel Diplomat, Prague, CSFR).
Sponsored by World Nuclear Fuel Market.
Contact: Donna Cason; 404-447-1144; Fax: 404-447-1797.

June 7-11 ***American Nuclear Society Annual Meeting*** (Boston Marriott, Copley Place, Boston, Massachusetts).
Contact: ANS Meetings Department; 708-352-6611.

June 23-24 ***Nuclear Forum '92*** (Royal Garden Hotel, London, United Kingdom).
Sponsored by the British Nuclear Forum.
Contact: Ms. Ipek Yigit, Manager for Public and Industrial Affairs, British Nuclear Forum; phone: 071-828-0116; Fax: 071-828-0110; Address: 22 Buckingham Gate, London, SW1E 6LB, England.

Sept. 9-11 ***Uranium Institute 17th Annual Symposium*** **(London, United Kingdom).**
Contact: 44-71-225-0303; Fax: 44-71-225-0308.

Sept. 20-23 ***International Uranium Seminar '92*** (Hyatt Regency Hotel, Lake Tahoe, Nevada).
Sponsored by the U.S. Council for Energy Awareness.
Contact: USCEA Conference Office; 202-293-0770; Telex: 7108249602; Fax: 202-785-4113.

Sept. 21-23 ***2nd International Conference on Training for Operation & Maintenance in the Nuclear Industry***
(The Moat House International Hotel, Stratford-upon-Avon, United Kingdom).
Sponsored by the Institution of Nuclear Engineers.
Contact: INE Conference Secretary; 081-698-1500 or 081-698-4750; Fax: 018-695-6409.

Sept. 29-Oct. 1 ***Crisis/Emergency Information Planners' Workshop*** (Loews L'Enfant Plaza, Washington DC)
Sponsored by the U.S. Council for Energy Awareness.
Contact: USCEA Conference Office; 202-293-0770; Telex: 7108249602; Fax: 202-785-4113.

Oct. 18-22 ***AMC Mining Convention*** (Las Vegas, Nevada)
Sponsored by the American Mining Congress.
Contact: AMC Convention Office; 202-861-2800; Fax: 202-861-7535.

Oct. 19-23 ***International Symposium on Geological Disposal of Spent Fuel, High-level and Alpha-bearing Wastes***
(Antwerp, Belgium).
Sponsored by the International Atomic Energy Agency.
Contact: IAEA, P.O. Box 100, A-1400 Vienna, Austria.

Nov. 15-18 ***International Nuclear Energy Forum*** (Fairmont Hotel, Chicago, Illinois).
Sponsored by the U.S. Council for Energy Awareness.
Contact: USCEA Conference Office; 202-293-0770; Telex: 7108249602; Fax: 202-785-4113.

Nov. 15-20 ***American Nuclear Society Winter Meeting*** (McCormick Center Hotel, Chicago, Illinois).
Contact: ANS Meetings Department; 708-352-6611.

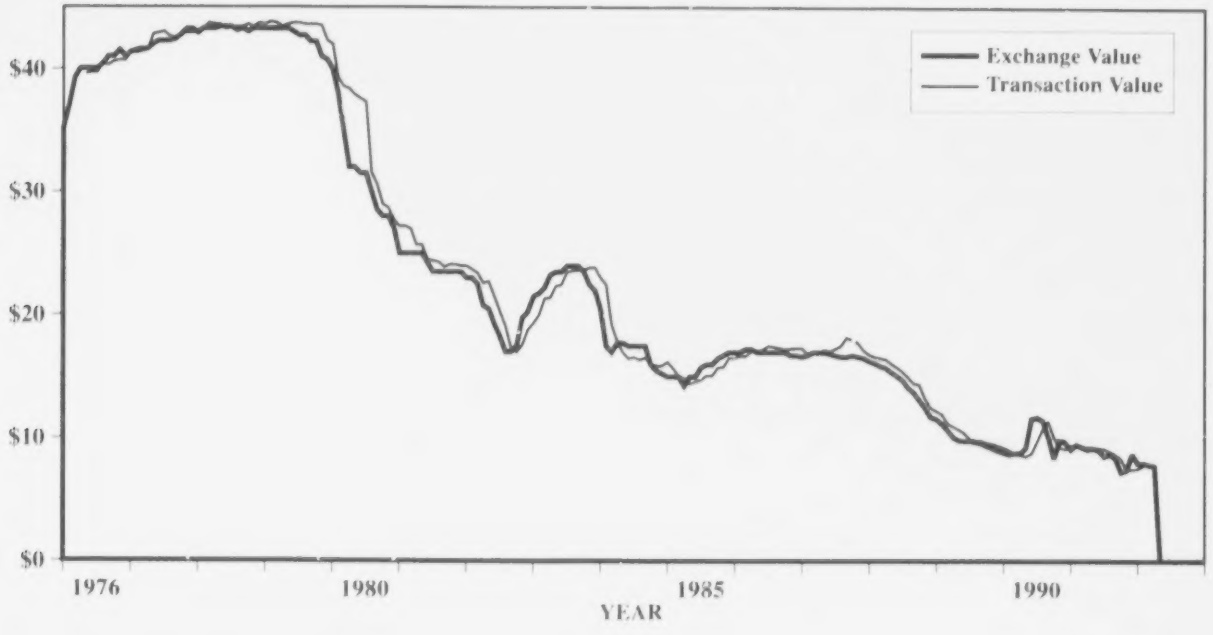
© NUEXCO 1992

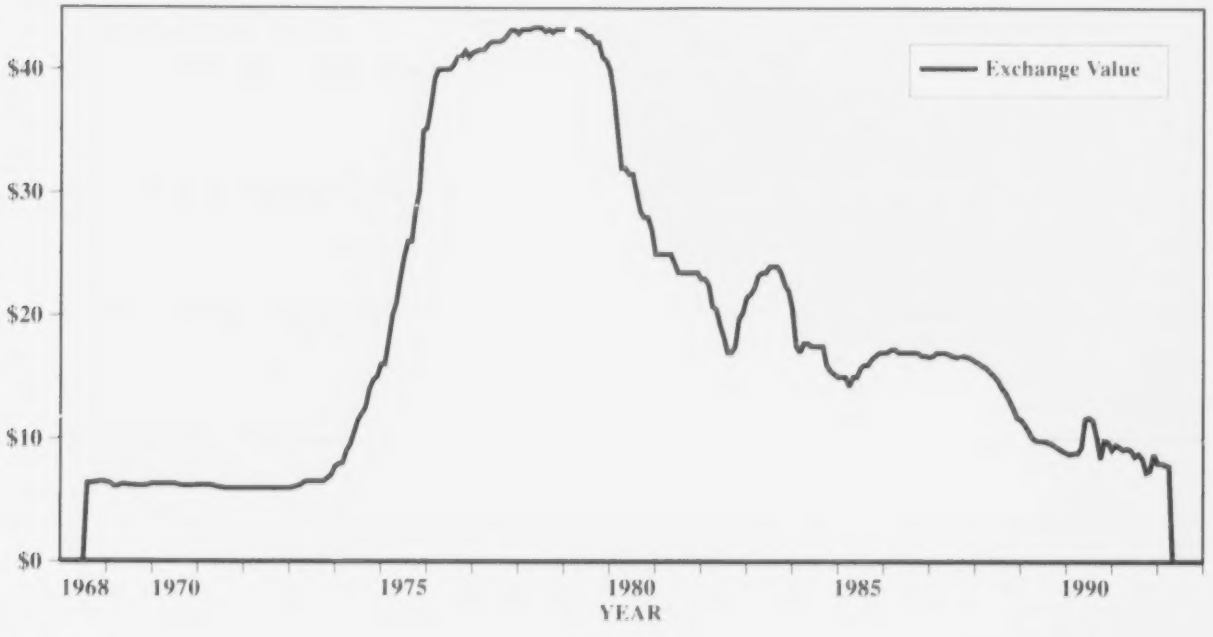
NUEXCO

HISTORICAL MARKET DATA

NUEXCO HISTORICAL EXCHANGE VALUE AND TRANSACTION VALUE

(in US dollars per pound U_3O_8)





© NUEXCO 1992

HISTORICAL MARKET VALUES

Exchange Values

Year	Determined as of the last day of the month indicated ($US/lb U_3O_8)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	6.35	6.35	6.40	6.45	6.50
1969	—	6.35	6.10	6.10	6.25	6.25	6.20	6.20	6.15	6.15	6.15	6.20
1970	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.20	6.15	6.15	6.15	6.15
1971	6.20	6.20	6.20	6.20	6.15	6.05	6.00	5.95	5.95	5.95	5.95	5.95
1972	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95	5.95
1973	5.95	6.00	6.10	6.20	6.45	6.50	6.50	6.50	6.50	6.50	6.75	7.00
1974	7.70	7.90	8.00	9.00	9.50	10.50	11.50	12.00	12.50	14.00	14.75	15.00
1975	16.00	16.00	18.00	20.00	21.00	23.00	24.70	26.00	26.00	28.50	30.00	35.00
1976	35.20	37.00	39.25	40.00	40.00	40.00	40.00	40.40	41.00	41.00	41.50	41.00
1977	41.35	41.50	41.60	41.60	42.00	42.25	42.25	42.25	42.40	42.75	43.20	43.20
1978	42.90	43.25	43.25	43.25	43.40	43.40	43.40	43.10	43.25	43.00	43.25	43.25
1979	43.25	43.25	43.25	43.25	43.25	43.00	42.70	42.70	42.20	42.20	41.00	40.75
1980	40.00	38.00	35.00	32.00	32.00	31.50	31.50	30.00	28.50	28.00	28.00	27.00
1981	25.00	25.00	25.00	25.00	25.00	24.25	23.50	23.50	23.50	23.50	23.50	23.50
1982	23.00	23.00	22.50	20.75	20.50	19.25	18.25	17.00	17.00	17.50	19.75	20.25
1983	21.50	21.75	22.25	23.25	23.50	23.50	24.00	24.00	24.00	23.50	22.50	22.00
1984	20.50	17.50	17.00	17.75	17.75	17.50	17.50	17.50	17.50	16.00	15.50	15.25
1985	15.00	15.00	15.00	14.25	15.00	15.00	15.75	16.00	16.00	16.50	16.75	17.00
1986	17.00	17.00	17.25	17.25	17.00	17.00	17.00	17.00	17.00	17.00	16.75	16.75
1987	16.65	16.75	17.00	17.00	17.00	16.90	16.75	16.65	16.65	16.75	16.65	16.55
1988	16.30	16.15	15.90	15.75	15.40	15.10	14.75	14.15	13.75	13.15	12.50	11.75
1989	11.60	11.20	10.70	10.10	9.85	9.80	9.80	9.70	9.60	9.40	9.20	9.00
1990	8.85	8.70	8.80	8.80	9.25	11.60	11.70	11.45	10.10	8.35	9.80	9.70
1991	9.10	9.50	9.30	9.10	9.20	9.05	8.55	8.75	8.40	7.25	7.40	8.75
1992	8.00	8.00	7.85	**7.75**								

US Premium (Relative to the Exchange Value)

Year	Determined as of the last day of the month indicated ($US/lb U_3O_8)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1986	—	—	—	—	—	—	—	—	—	—	0.65	0.75
1987	0.85	1.00	1.50	1.50	0.90	0.60	2.50	2.35	2.10	1.65	0.85	0.65
1988	0.70	0.50	0.15	0.25	0.60	0.00	0.00	0.00	0.00	0.00	**Discontinued**	

© NUEXCO 1992

NUEXCO

HISTORICAL MARKET DATA

UF_6 Values

Determined as of the last day of the month indicated ($US/kg U as UF_6)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1985	—	—	—	40.50	42.50	42.50	44.00	44.50	44.50	46.00	46.00	47.00
1986	47.00	48.00	48.00	48.50	48.25	48.25	48.25	48.00	48.00	48.00	48.00	47.75
1987	47.75	48.00	48.00	48.00	47.75	47.75	47.50	47.00	46.75	47.00	47.00	47.00
1988	46.50	46.00	45.50	45.25	44.75	44.00	42.75	41.00	40.75	39.00	37.50	35.50
1989	34.75	34.00	33.00	30.50	30.25	30.25	30.00	29.75	29.75	28.25	27.75	26.50
1990	25.90	25.25	24.40	24.40	25.50	32.00	32.50	32.25	29.50	24.75	28.75	28.75
1991	27.50	27.75	27.50	27.25	27.60	27.25	25.75	26.25	25.50	22.75	22.75	26.00
1992	24.50	24.25	24.00	**23.75**								

US Premium (Relative to the UF_6 Value)

Determined as of the last day of the month indicated ($US/kg U as UF_6)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1986	—	—	—	—	—	—	—	—	—	—	2.50	2.50
1987	2.50	2.50	3.50	3.00	2.25	1.75	6.50	6.00	4.25	3.10	2.25	2.00
1988	1.25	1.25	0.50	0.50	1.00	0.00	0.00	0.00	0.00	0.00	**Discontinued**	

Conversion Values

Determined as of the last day of the month indicated ($US/lb U as UF_6)

Year	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1981	1.20	1.20	1.20	1.40	1.15	1.15	1.15	1.10	1.10	1.10	1.20	1.20
1982	1.20	1.20	1.20	1.20	1.00	1.00	1.00	0.90	1.10	1.60	1.45	1.45
1983	1.20	1.40	1.40	1.20	1.20	1.20	1.10	1.10	1.00	0.60	0.60	0.60
1984	0.60	0.30	0.80	0.80	0.80	0.00	0.00	0.80	1.00	1.00	0.80	0.80
1985	1.00	1.00	1.00	1.50	1.50	1.60	1.60	1.60	1.60	1.60	1.60	1.60
1986	1.60	1.80	1.90	1.80	1.80	1.80	1.80	1.90	1.90	1.90	1.80	1.80
1987	1.80	1.80	1.80	1.80	1.80	1.80	1.90	1.90	1.90	1.90	1.90	1.90
1988	1.90	1.80	1.80	1.80	1.80	1.80	1.85	1.95	1.95	1.95	1.95	1.95
1989	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.90	1.90	1.80	1.75	1.65
1990	1.50	1.50	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
1991	1.45	1.45	1.45	1.45	1.50	1.50	1.50	1.60	1.55	1.55	1.55	1.55
1992	1.60	1.60	1.60	**1.60**								

© NUEXCO 1992

Transaction Values

Year	Determined as of the last day of the month indicated ($US/lb U_3O_8)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1976	—	—	—	—	39.60	39.70	39.70	40.40	40.30	40.60	40.70	40.70
1977	41.30	41.30	41.40	41.50	42.80	42.90	43.00	42.60	42.50	42.80	42.90	42.90
1978	43.10	43.30	43.70	43.60	43.60	43.20	43.30	43.40	43.40	43.60	43.40	43.70
1979	43.60	43.80	43.70	43.40	43.60	43.70	43.70	43.60	43.60	43.60	43.50	42.30
1980	42.00	39.30	38.60	38.40	37.90	37.60	37.30	31.60	30.60	29.00	28.70	27.70
1981	27.20	27.20	27.00	25.70	25.70	24.50	24.40	24.30	23.90	24.10	24.10	24.00
1982	24.00	23.70	23.40	22.60	22.70	21.50	20.30	19.10	17.30	17.00	17.55	18.80
1983	19.35	20.00	21.35	21.40	22.35	22.45	23.50	23.60	23.65	23.65	23.85	23.85
1984	23.05	22.50	19.25	17.90	17.00	16.50	16.60	16.40	16.55	16.05	15.90	15.90
1985	16.20	15.70	15.05	14.90	14.45	14.60	14.75	15.10	15.10	15.75	15.80	16.55
1986	16.55	16.70	16.70	17.10	17.15	17.20	17.50	17.45	17.35	17.25	17.30	17.35
1987	17.35	16.90	16.95	17.00	17.20	17.10	17.30	17.55	18.20	18.05	17.80	17.20
1988	16.85	16.65	16.55	16.45	16.10	15.80	15.45	15.00	14.50	14.40	13.30	12.50
1989	12.25	12.00	11.25	11.00	10.75	10.45	9.95	9.80	9.80	9.65	9.55	9.40
1990	9.25	9.05	8.75	8.65	8.55	8.80	9.75	10.80	11.40	10.10	9.30	9.15
1991	9.40	9.45	9.35	9.30	9.30	9.20	9.15	8.95	8.70	8.35	7.45	7.50
1992	7.55	7.80	7.95	**7.90**								

SWU Values

Year	Determined as of the last day of the month indicated ($US per SWU)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1986	80	80	80	80	75	78	78	78	78	78	80	80
1987	80	80	77	77	75	73	75	75	73	69	73	73
1988	73	73	70	68	68	68	68	65	65	65	65	65
1989	65	67	67	67	66	66	66	65	63	59	57	54
1990	54	50	50	50	50	50	50	50	50	51	51	51
1991	51	50	52	52	54	59	66	67	67	68	68	70
1992	71	70	69	**67**								

© NUEXCO 1992

NUEXCO

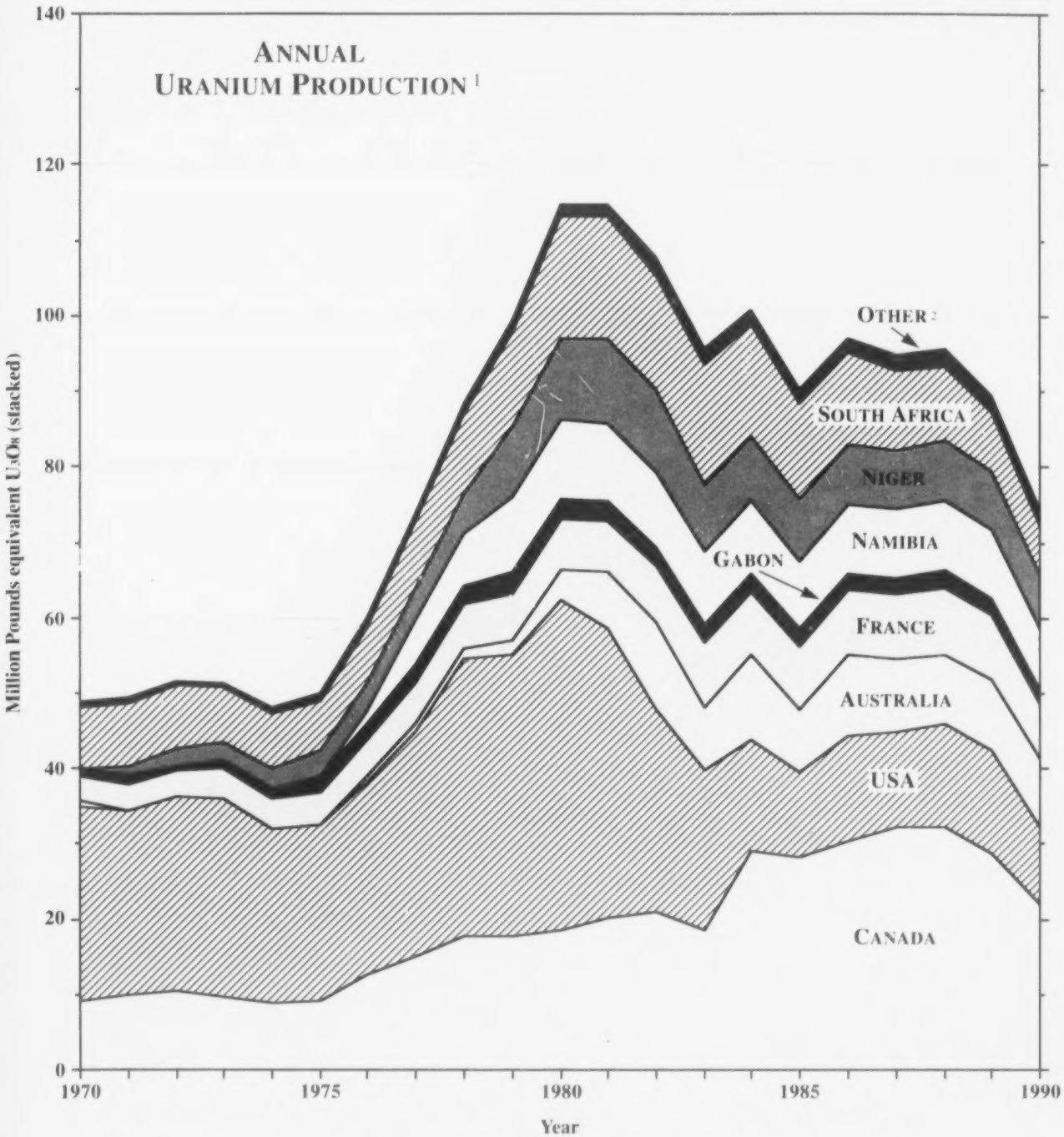
HISTORICAL MARKET DATA

Loan Rates

Year	Determined as of the last day of the month indicated (Percent per Annum)											
	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1968	—	—	—	—	—	—	—	4.00	4.00	4.00	4.00	4.00
1969	4.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00	6.00	6.00	6.00	6.00
1970	6.00	6.20	6.40	6.50	6.50	6.50	6.50	5.00	6.50	6.00	5.50	5.50
1971	5.00	4.75	4.75	4.75	5.00	5.25	5.25	5.25	5.25	5.25	4.50	4.50
1972	4.00	4.00	4.00	4.50	4.50	4.50	5.00	5.00	5.00	5.00	5.00	5.00
1973	5.50	5.50	5.75	5.75	6.00	6.25	7.00	7.00	7.00	7.00	7.50	8.00
1974	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
1975	8.00	7.00	7.00	7.00	7.00	6.50	6.50	6.50	6.50	6.50	6.50	6.50
1976	6.50	6.50	6.50	6.50	*	*	*	*	*	*	*	*
1977	*	*	*	*	6.50	6.50	6.50	6.75	7.25	7.25	7.25	7.25
1978	7.25	7.00	7.00	7.00	7.00	7.50	7.75	7.75	7.75	7.00	7.00	7.00
1979	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
1980	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00
1981	7.00	7.00	7.00	7.00	7.00	5.50	5.50	5.50	5.50	6.00	6.00	6.00
1982	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1983	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1984	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
1985	6.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
1986	5.00	5.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
1987	3.00	3.00	3.00	3.00	3.00	3.00	3.00	4.00	4.00	4.00	3.50	3.50
1988	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
1989	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
1990	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
1991	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.00
1992	3.00	3.00	3.00	**3.00**								

* Float with Prime Rate

© NUEXCO 1992



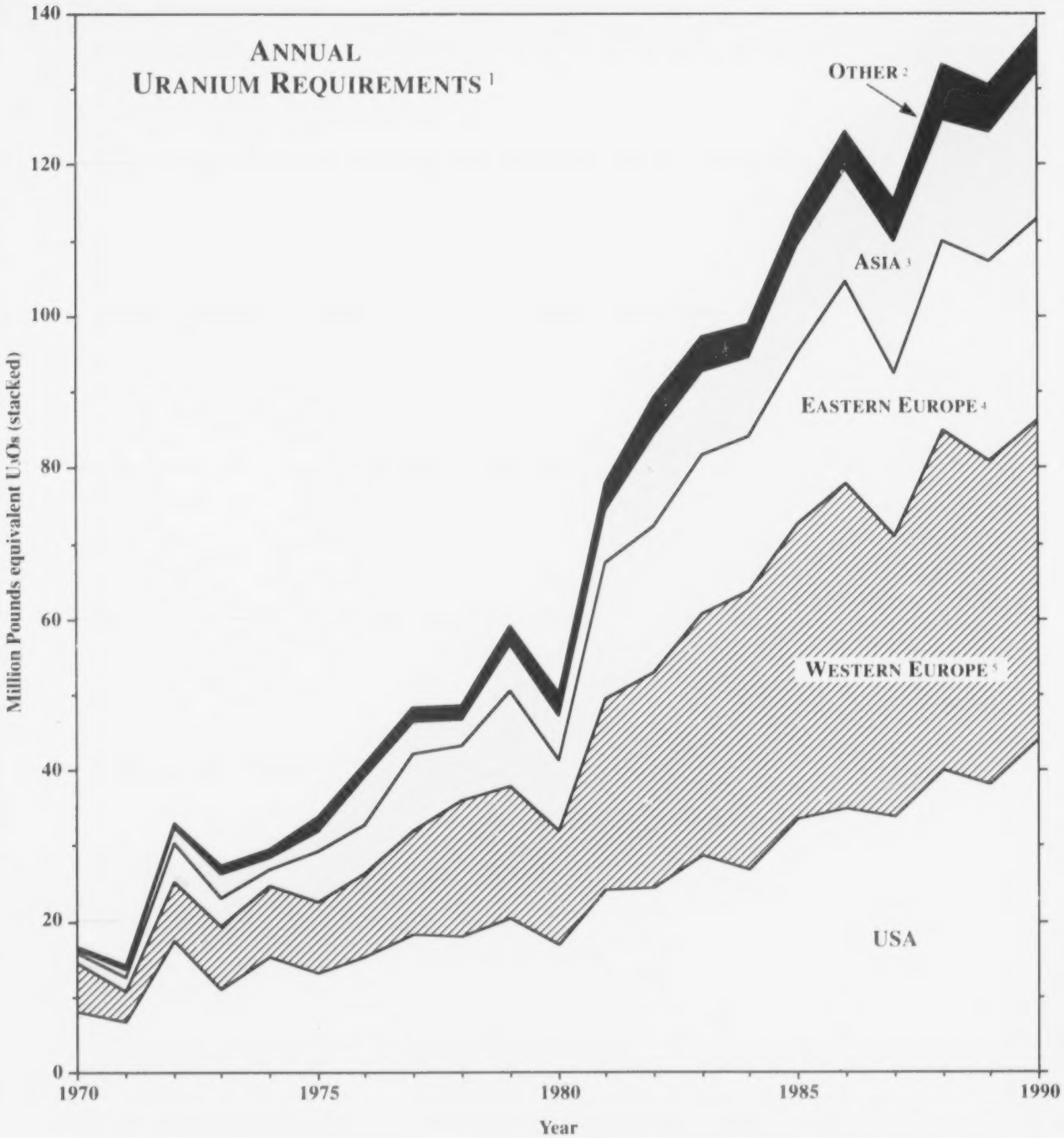
[1] Estimated western world uranium production in 1990 totalled 74.5 million pounds equivalent U_3O_8 —
(Australia: 9.1 – Canada: 22.0 – France: 7.4 – Gabon: 1.8 – Namibia: 8.0 – Niger: 7.4 – South Africa: 6.4 – USA: 10.2 – Other[2]: 2.2)

[2] **Other** includes: Argentina, Belgium, Brazil, India, Pakistan, Portugal, Spain, former West Germany, and Yugoslavia (Slovenia).

© NUEXCO 1992

NUEXCO

HISTORICAL MARKET DATA



[1] Calculated by NUEXCO based on actual completion dates and operating performance, and NUEXCO's estimate of enriching tails assay.
[2] **Other** includes: Argentina, Brazil, Canada, India, Mexico, Pakistan, and South Africa.
[3] **Asia** includes: Japan, People's Republic of China, South Korea, and Taiwan.
[4] **Eastern Europe** includes: Bulgaria, Czechoslovakia, former East Germany, Finland, Hungary, former Soviet Union, and Yugoslavia (Slovenia).
[5] **Western Europe** includes: Belgium, France, former West Germany, Italy, The Netherlands, Spain, Sweden, Switzerland, and UK.

© NUEXCO 1992

Australia

Year	Period [1]	Consumer Price Index [2] (1980/1981 = 100)	Price Index of Materials Used in Manufacturing Industry — All Groups [3] (1984/1985 = 100)	Average Weekly Ordinary Time Earnings — Adult Males — Australia [4] (Australian dollars)	Award Rates of Pay Indexes Australia - Adult Males In Mining Wage Earners, Weekly Rates [5] (June 1985 = 100)
1980	Avg.	95.8	83.1	—	69.6
1981	Avg.	105.0	85.9	—	76.1
1982	Avg.	116.7	89.0	—	86.4
1983	Avg.	128.5	96.9	—	89.9
1984	Avg.	133.6	98.0	—	96.0
1985	Avg.	142.6	107.3	—	100.0
1986	Avg.	155.5	101.5	—	104.9
1987	Avg.	168.7	108.9	465.88	112.9
1988	Avg.	180.9	111.8	496.90	115.4
1989	Avg.	194.6	117.0	534.65	126.0
1990	Avg.	208.7	123.4	571.43	129.7
1991	Avg.	215.5	120.1	600.35	133.8
Jan	1991	—	125.6	—	133.0
Feb	1991	—	121.5	597.70	133.0
Mar	1991	214.1	119.1	—	133.3
Apr	1991	—	117.6	—	133.5
May	1991	—	117.8	592.00	133.5
June	1991	214.4	120.4	—	133.5 **R**
July	1991	—	120.4	—	133.6
Aug	1991	—	119.9	599.50	133.9 **R**
Sept	1991	215.7	118.3	—	134.2 **R**
Oct	1991	—	118.7	—	134.2 **R**
Nov	1991	—	120.6	612.20	134.4 **R**
Dec	1991	217.7	121.2	—	134.4 **R**
Jan	1992	—	120.9	—	134.6
Feb	1992	—	120.9	—	—

P = Preliminary **R** = Revised since last month

[1] Monthly data for the period 1967 to 1990 appears in NUEXCO Monthly Report 278.

[2] Weighted average of six State capital cities (1975 to 1980), and eight capital cities from 1981 (Base: Financial year July 1980 to June 1981 = 100.0). Figures shown at end of quarter represent quarterly average.

[3] Australian Bureau of Statistics, Canberra: "Price Index of Materials Used in Manufacturing Industry" (CATALOGUE No. 6411.0).

[4] Australian Bureau of Statistics, Canberra: "Award Rates of Pay Indexes, Australia" (CATALOGUE No. 6312.0). Figures for the latest fourteen months shown are subject to revision.

[5] Australian Bureau of Statistics, Canberra: "Average Weekly Earnings, States & Australia" (CATALOGUE No. 6302.0).

© NUEXCO 1992

Canada

Year	Period	Industrial Products Price Index: All Commodities [1] (1986 = 100) [2]	Consumer Price Index: All Items (1986 = 100) [3]	Wage-earner Data: Average Hourly Earnings (C$) [4] Uranium Mines (SIC 057)	Metal Mines (SIC 051-059)	Mines, Quarries and Oil Wells (SIC 051-099)	Metal Rolling, Casting and Extruding (SIC 298)	Chemicals and Chemical Products Industries (SIC 372-379)
1980	Avg.	75.9	67.2	—.—	—.—	—.—	—.—	—.—
1981	Avg.	83.6	75.5	—.—	—.—	—.—	—.—	—.—
1982	Avg.	89.0	83.7	—.—	—.—	—.—	—.—	—.—
1983	Avg.	92.1	88.5	17.22	14.86	14.18	10.67	11.09
1984	Avg.	96.3	92.4	17.89	15.85	14.97	11.11	11.68
1985	Avg.	99.0	96.0	18.53	16.47	15.56	11.85	12.12
1986	Avg.	100.0	100.0	19.38	16.70	15.76	12.28	12.58
1987	Avg.	102.8	104.4	20.12	17.15	16.11	12.58	13.20
1988	Avg.	107.2	108.6	20.91	18.51	16.95	13.17	13.77
1989	Avg.	109.4	114.0	21.97	20.02	18.41	13.71	14.16
1990	Avg.	109.7	119.4	22.90	20.93	19.12	14.62	15.28
1991	Avg.	108.7	126.2	24.35	22.27	20.28	14.83	16.45
Jan	1991	111.1	125.0	23.79	21.79	19.78	14.66	15.89
Feb	1991	110.6	125.0	25.23	22.45	20.13	14.63	16.10
Mar	1991	109.8	125.5	24.19	22.22	20.27	15.21	16.47
Apr	1991	109.1	125.5	24.77	22.50	20.31	14.63	16.64
May	1991	108.6	126.1	24.38	22.17	20.25	15.05	16.55
June	1991	108.5	126.7	23.58	22.13	19.90	14.65	16.51
July	1991	108.2	126.8	24.70	22.33	19.93	14.56	16.36
Aug	1991	107.8	126.9	23.78	22.01	20.00	14.62	16.24
Sept	1991	107.6	126.7	24.23	22.27	20.38	14.89	16.47
Oct	1991	107.4 **R**	126.5	24.40	22.26	20.53	15.06	16.55
Nov	1991	107.3 **R**	127.0	24.58	22.44	20.79	14.85	16.62
Dec	1991	107.2 **R**	126.4	24.53	22.70	21.13	15.16	17.04
Jan	1992	107.2 **R**	127.0	24.79 **R**	22.67 **R**	21.20 **R**	15.53 **R**	16.97 **R**
Feb	1992	108.0 **R**	127.1	24.45 **P**	22.44 **P**	21.06 **P**	15.93 **P**	16.83 **P**
Mar	1992	108.3	127.5	—.—	—.—	—.—	—.—	—.—

P = Preliminary **R** = Revised since last month

[1] Statistics Canada, Prices Division, Ottawa: "Industry Price Indexes" (CATALOGUE 62-011). Indexes for the most recent six months shown are subject to revision. This category was formerly known as "Manufacturing." Monthly data for the period 1967 to 1990 is found in NUEXCO Monthly Report 278.

[2] New Base Year of 1986 as of NUEXCO Monthly Report 266. Previous Base Year was 1981.

[3] New Base Year of 1986 as of NUEXCO Monthly Report 264. Previous Base Year was 1981.

[4] Statistics Canada, Labour Division, Employment and Payrolls Section, Ottawa: "Employment, Earnings and Hours." Monthly data for the period 1983 to 1990 is found in NUEXCO Monthly Report 278.

© NUEXCO 1992

South Africa

Year	Period	Average Declared Working Costs per Metric Ton of Gold Ore Milled [1] (Rand)	Tonnage-Weighted Index of Average Working Costs per Metric Ton of Gold Ore Milled [2] (March 1982 = 100)	Consumer Price Index [3] (1990 = 100)	Production Price Index All Groups [4] (1990 = 100)	Total Employment in Mining and Quarrying [5]	Total Salaries and Wages in Mining and Quarrying [5] (1,000 Rand)
							Annual Total [6]
1980	Avg.	35.50	—	25.5	27.7 R	709,042	2,237,689
1981	Avg.	41.87	—	29.4	31.5	722,918	2,756,928
1982	Avg.	47.23	103.9	33.7	35.9	702,041	3,181,584
1983	Avg.	51.88	115.0	37.8	39.7	700,901	3,563,282
1984	Avg.	58.95	130.3	42.2	43.0	711,511	4,134,390
1985	Avg.	68.70	151.7	49.1	50.3	724,587	4,778,612
1986	Avg.	80.18	177.9	58.2	60.1	756,637	5,767,950
1987	Avg.	95.01	223.1	67.6	68.5	751,864	6,911,395
1988	Avg.	106.69	241.1	76.2	77.5	705,355	7,774,054
1989	Avg.	116.65	273.0	87.4	89.3 R	700,360	8,833,934
1990	Avg.	129.37	305.3	100.0	100.0	677,742	10,193,209
1991	Avg.	136.06	322.4 R	115.2	111.4	630,722	10,934,073
							Monthly Total
Jan	1991	—	—	107.7	108.6	648,944	935,839
Feb	1991	—	—	109.0	109.0	650,948	893,373
Mar	1991	137.66	323.82	110.0	108.2	651,843	924,930
Apr	1991	—	—	111.5	108.8	639,939	887,722
May	1991	—	—	113.2	109.8	630,481	887,107
June	1991	134.65	317.23	114.0	110.3	640,908	890,595
July	1991	—	—	115.5	111.2	637,581	881,182
Aug	1991	—	—	117.1	112.0	633,699	963,710
Sept	1991	137.11	329.05	118.7	113.2	639,535	1,014,424
Oct	1991	—	—	119.8	114.8	584,435 R	860,529 R
Nov	1991	—	—	120.9 R	115.3	602,461	853,864
Dec	1991	134.81	319.33 R	122.5 R	115.8	602,486	940,798
Jan	1992	—	—	125.1	115.9	—	—
Feb	1992	—	—	126.2	116.3	—	—
Mar	1992	139.69	331.46	127.3	—	—	—

P = Preliminary **R** = Revised since last month

[1] Chamber of Mines of South Africa, Johannesburg: "Analysis of Working Results," published quarterly. Historical Data by month appears in NUEXCO Monthly Report 278.

[2] Page 16 of Report 178 contains description and calculation of index.

[3] Central Statistical Service, Pretoria: All income groups-weighted average. Historical Data by month appears in NUEXCO Monthly Report 278.

[4] Central Statistical Service, Pretoria: All commodities for consumption in South Africa. Base Year changed from 1985 to 1990 in NUEXCO Monthly Report 284.

[5] Central Statistical Service, Pretoria: Historical Data by month appears in NUEXCO Monthly Report 236.

[6] Annual total is shown, rather than monthly average, for indicated year.

© NUEXCO 1992

NUEXCO

GOVERNMENT STATISTICS

United States

Year	Period	Producer Price Index [1] Industrial Commodities (1982 = 100)	Producer Price Index [1] All Commodities (1982 = 100)	GNP Consumer Price Index [2] (1982-1984 = 100)	Implicit Price Deflator [3] (1987 = 100)	Gross Average Hourly Earnings of Production or Non-supervisory Workers (US$) [4] Metal Mining (SIC 10)	Primary Non-ferrous Metals (SIC 333)	Chemicals and Allied Products (SIC 28)	Electric and Electronic Equipment (SIC 36)
1980	Avg.	88.0	89.8	82.4	71.7	10.26	10.63	8.31	6.94
1981	Avg.	97.4	98.0	90.9	78.9	11.55	11.98	9.12	7.62
1982	Avg.	100.0	100.0	96.5	83.8	12.31	12.93	9.96	8.21
1983	Avg.	101.1	101.3	99.6	87.2	12.58	13.43	10.58	8.66
1984	Avg.	103.3	103.7	103.9	91.0	13.05	13.43	11.07	9.04
1985	Avg.	103.7	103.2	107.6	94.4	13.38	13.74	11.57	9.46
1986	Avg.	100.0	100.2	109.6	96.9	12.46	13.48	11.98	9.65
1987	Avg.	102.6	102.8	113.6	100.0	12.52	12.98	12.37	9.88
1988	Avg.	106.3	106.9	118.3	103.9	13.24	13.26	12.71	9.79
1989	Avg.	111.6	112.2	124.0	108.4	13.59	13.72	13.09	10.05
1990	Avg.	115.8	116.3	130.7	112.9	14.10	14.36	13.54	10.32
1991	Avg.	116.5	116.5	136.2	117.0	14.89	14.64	14.07	10.73
Jan	1991	119.3	119.0	134.6	—	14.73	14.63	13.85	10.60
Feb	1991	117.2	117.2	134.8	—	14.80	14.55	13.81	10.59
Mar	1991	115.6	116.1	135.0	115.9	14.93	14.55	13.85	10.55
Apr	1991	115.6	116.0	135.2	—	14.85	14.56	13.96	10.63
May	1991	116.1	116.5	135.6	—	14.79	14.52	14.01	10.66
June	1991	116.1	116.4	136.0	116.8	14.88	14.51	14.05	10.74
July	1991	116.0	116.1	136.2	—	15.09	14.56	14.16	10.77
Aug	1991	116.3	116.2	136.6	—	14.82	14.64	14.06	10.78
Sept	1991	116.3	116.1	137.2	117.4	15.04	14.59	14.21	10.84
Oct	1991	116.7	116.4	137.4	—	14.94	14.75	14.25	10.78
Nov	1991	116.7	116.4	137.8	—	15.29	14.89	14.27	10.88
Dec	1991	116.1	115.9	137.9	117.9	15.13	14.87	14.34	10.96
Jan	1992	115.6	115.6	138.1	—	15.06 R	14.74	14.30 R	10.90
Feb	1992	116.0	116.1	138.6	—	15.21 P	14.71 P	14.29 R	10.91 R
Mar	1992	115.9	116.1	139.3	—	—.—	—.—	14.33 P	10.93 P

P = Preliminary **R** = Revised since last month

[1] US Bureau of Labor Statistics, Washington, DC: "Producer Prices and Price Indexes," (formerly "Wholesale Prices and Price Indexes"). Producer Price Indexes are revised four months after they are first released to reflect the availability of late reports and corrections by respondents Historical data is presented in NUEXCO Monthly Report 278.

[2] US Bureau of Labor Statistics, Washington, DC: Consumer Price Index for All Urban Consumers, US City Average, All Items. Historical data is presented in NUEXCO Monthly Report 278.

[3] US Department of Commerce, Washington, DC: Bureau of Economic Analysis, National Income and Wealth Division: "Survey of Current Business." The GNP Implicit Price Deflator is published quarterly, and seasonally adjusted. Historical data is presented in Report 278. Base Year change from 1982 to 1987 in NUEXCO Monthly Report 284.

[4] US Bureau of Labor Statistics, Washington, DC: "Employment and Earnings." All data based on 1972 revision of SIC Manual. Historical data is presented in NUEXCO Monthly Report 278.

© NUEXCO 1992

Uranium Deliveries To The European Community[1]

— Compiled from data published by the Euratom Supply Agency —

Year	Volume of Deliveries to the EC[2] (MTU)	Percentage of Deliveries Made Under Spot Contracts	Medium or Long-Term Contracts[3] Average Price		Spot Contracts[3] Average Price	
			in ECU per pound U_3O_8	in US Dollars per pound U_3O_8	in ECU per pound U_3O_8	in US Dollars per pound U_3O_8
1977	n/a	n/a	n/a	n/a	n/a	$41.00
1978	n/a	n/a	n/a	n/a	n/a	$43.00
1979	10,000	n/a	n/a	n/a	n/a	$44.50
1980	8,600	n/a	n/a	$36.00	n/a	$35.00
1981	13,000	less than 10	n/a	$33.25	n/a	$28.00
1982	12,500	less than 10	ECU 32.25	$32.00	ECU 24.25	$24.00
1983	13,500	less than 10	ECU 34.75	$31.00	ECU 26.00	$23.25
1984	11,000	less than 10	ECU 37.75	$29.75	ECU 24.50	$19.25
1985	11,000	11.5	ECU 38.00	$29.00	ECU 19.50	$15.00
1986	12,000	9.5	ECU 31.50	$31.00	ECU 18.00	$17.75
1987	14,000	17.0	ECU 28.25	$32.50	ECU 15.00	$17.25
1988	12,500	4.5	ECU 26.92	$31.82	ECU 13.65	$16.13
1989	13,500	11.5	ECU 26.63	$29.35	ECU 11.04	$12.19
1990	12,800	16.7	ECU 23.08	$29.39	ECU 7.60	$ 9.68

P = Preliminary **R** = Revised since last month

1 The twelve European Community member nations are Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, and the United Kingdom; prior to January 1986, Spain and Portugal were not members of the EEC.

2 The only deliveries taken into account are those made to final users, namely the electric utilities or their procurement organizations; deliveries to middlemen or fuel cycle companies are not included. The sales between utilities in the Community are also excluded. The quantities covered are those which were entered into accounting records during the year stated.

3 For deliveries made under medium or long-term contracts (i.e., for which the time between the date of signature and the date of the last delivery exceeds one year) the prices were expressed in seven different currencies. In order to calculate an average price, these prices have been converted into European Currency Units (ECU) and US dollars. The average prices were weighted by quantity and converted on the basis of the average annual exchange rate of the different currencies against the ECU and US dollar. Exchange rates are published by European Communities Statistical Office and the International Monetary Fund.

© NUEXCO 1992

NUEXCO

GOVERNMENT STATISTICS

US Uranium Marketing Data

— Compiled from data published by the US Energy Information Administration [1] —

Year	Total Production (million pounds U_3O_8)	Deliveries to Domestic Utilities From US Suppliers [2] (million pounds U_3O_8)	Average Price of Delivered Uranium [2] ($/lb. U_3O_8)	Quantity of Uranium Imported [3] (million pounds U_3O_8)	Average Price of Imported Uranium ($/lb. U_3O_8)	Quantity of Uranium Exported (million pounds U_3O_8)
1976	25.5	27.6	$16.10	3.6	n/a	1.2
1977	29.9	27.8	$19.75	5.6	n/a	4.0
1978	37.0	31.6	$21.60	5.2	n/a	6.8
1979	37.5	33.0	$23.85	3.0	n/a	6.2
1980	43.7	35.0	$28.15	3.6	$43.10	5.8
1981	38.5	32.6	$34.65	6.6	$32.90	4.4
1982	26.9	23.5	$38.37	17.1	$25.19	6.2
1983	21.2	24.2	$38.21	8.2	$26.16	3.3
1984	14.9	22.5	$32.65	12.5	$21.86	2.2
1985	11.3	21.7	$31.43	11.7	$20.08	5.3
1986	13.5	18.9	$30.01	13.5	$20.07	1.6
1987	13.0	20.8	$27.37	15.1	$19.14	1.0
1988	13.1	17.6	$26.15	15.8	$19.03	3.3
1989	13.8	18.4	$19.56	13.1	$16.75	2.1
1990	8.9	20.5	$15.70	23.7	$12.55	2.0

P = Preliminary **R** = Revised since last month

[1] Sources: 1976-1983: US Department of Energy/Energy Information Administration, *Survey of United States Marketing Activity.* 1984-1990: Energy Information Administration, *Uranium Industry Annual.*

[2] Data for 1976-1981 includes both domestic utilities and agents.

[3] Includes imports by domestic utilities and domestic suppliers.

© NUEXCO 1992

NUEXCO

INTERNATIONAL ADVISORY COMMITTEE

J. Robert (Bob) Wolcott
Chairman
USA

* * *

Lars Halle
Sweden

O. J. C. (John) Runnalls
Canada

George J. Stathakis
USA

James C. C. Stewart
United Kingdom

W. Bryan Webster
USA

Ken C. Whyte
South Africa

REPRESENTATIVES

JAPAN:

Kazuo Yokota
Japan Tech Services
Ohkura Building (3F)
1-4-10 Shiba Daimon
Minato-ku, Tokyo 105, Japan
Telephone: (81-3) 3431-6031, -6034
Fax: (81-3) 3434-6674
Telex: 242-5060 (JATECH J)

SOUTH AFRICA:

Chris I. Von Christierson
Southern Prospecting (Pty) Limited
Mailing Address:
Post Office Box 61409
Marshalltown 2107
Republic of South Africa
Street Address:
7th Floor, Marshall Place
66 Marshall Street
Johannesburg 2001
Telephone: (27-11) 834-4211
Fax: (27-11) 834-6343
Telex: 4-89878-SA

TAIWAN:

Dr. Steve H.K. Wang
Southeast Engineering Corporation
Yu-Ming Mansion
7, Roosevelt Rd., Sec. 1, 7th Floor
Taipei, 10757, Taiwan R.O.C.
Telephone: (886-2) 321-0216
Fax: (886-2) 394-2621
Telex: 11285 (SENCORP)

UNITED STATES:

Harold C. Lindberg
83-A Hardee Lane
Whispering Pines, North Carolina 28327
Telephone: (919) 949-3622
Fax: (919) 949-2626

Ralph O. Smith
141 Braemar Drive
Cheshire, Connecticut 06410
Telephone: (203) 272-6246
Fax: (203) 271-1346

© NUEXCO 1992

INTERNATIONAL HEADQUARTERS

Three Park Central, Suite 1000
1515 Arapahoe Street
Denver, Colorado 80202-U.S.A.

Telephone: (303) 899-4500
Fax: (303) 899-4555
Telex: 450202 NEUXCO